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UNITED STATES DEPARTMENT OF AGRICULTURE
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New Orleans, Louisiana

REPORT OF STUDIES ON UNIFORMITY OF QUALITY OF SUGARS

1. Chemical Studies on Beet Sugars of the 1942 Campaign
By C. A. Fort and S. Byall

11. Report on Biological Studies of Sugars
By H. H. Hall and Caroline C. Clark

Agricultural Chemical Research Division

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PART I

CHEMICAL STUDIES ON BEET SUGARS OF THE 1942 CAMPAIGN

By C.A. Fort and S. Byall

Campaign composites of the sugar produced at 80 of the factories operating during the 1942 sugar beet harvest were received and have been examined chemically, physically and biologically. Six additional beet sugars were also included in the studies. The factory operating data which were submitted with the samples, and the chemical and physical test results obtained on the sugars will be presented in this first portion of the report. The biological studies made by H.H. Hall and Caroline C. Clark will be found in Part II.

Due to circumstances beyond our control the work has been much delayed and it was necessary to eliminate certain determinations. As in recent reports, the data of all kinds are arranged in dual tables, the first part being for non-Steffen factories and the second part for the Steffen factories. Tables 1 through 4 cover the operating data, Tables 5 to 7 inclusive the analytical studies of the sugars, Table 8 the screening tests and Table 9 summarizes the average data for the four major geographical groups of factories. It was not possible to include any special studies and in general the methods used were the same as last year.

ACKNOWLEDGMENT

The active cooperation of the various sugar companies and personnel in submitting the samples and factory operating data which made these investigations possible is greatly appreciated. The evident care used in preparing and shipping the sugar samples and in filling out the information sheets is very commendable.

Table 1

PROCESS DATA, NON-STEFFEN

Sample Number	Beets Sucrose	Beets Purity	Diffusion Juice Brix	Diffusion Juice Purity	Lime Used %	Soda Ash lbs.	Carbonation Alkalinities 1st	Carbonation Alkalinities 2nd	2nd Carb'n. Temp. C°	2nd Carb'n. pH	Thin Juice pH
4203	14.30	87.2	10.3	87.2	1.37	0.34	0.066	--	85	9.2	7.8
4205	14.24	83.9	11.0	85.5	1.92	0.24	.076	0.018	103	8.8	8.5
4206	17.49	84.7	13.3	85.8	2.94	none	.082	.012	97	--	--
4208	16.83	88.6	13.0	90.2	2.08	none	.074	.015	83	--	8.0
4210	15.93	88.9	11.4	88.9	1.24	0.12	.068	--	90	9.2	7.8
4211	13.20	84.4	11.2	84.4	1.45	0.30	.079	--	85	9.4	8.0
4212	16.64	83.8	11.9	88.7	1.80	none	.063	.012	96	--	7.8
4214	16.72	85.4	13.7	87.0	2.15	none	.067	.014	88	8.8	8.5
4215	13.55	84.5	12.3	84.4	1.99	0.15	*--	--	95	9.0	8.5
4216	17.38	86.5	14.8	87.8	2.30	0.19	.067	.016	102	--	8.1
4217	17.38	87.4	14.6	86.8	2.75	0.25	.073	.018	98	9.1	8.3
4218	14.95	85.0	11.9	87.7	2.16	0.01	.092	.016	93	8.9	8.8
4222	13.33	85.7	9.7	85.7	1.41	0.14	.070	--	90	9.4	8.1
4223	14.51	81.4	9.6	83.3	2.74	0.36	.093	--	98	8.8	8.7
4225	15.02	88.1	9.9	88.1	1.20	0.17	.068	--	--	9.4	7.8
4232	13.75	88.2	9.6	88.2	1.44	0.18	.084	--	85	9.4	7.9
4234	16.27	84.4	14.2	85.0	1.90	0.56	.078	--	74	8.7	8.7
4235	16.38	85.9	12.4	87.4	1.87	0.03	.076	--	95	8.9	8.0
4236	14.04	83.2	11.2	84.3	3.25	0.15	.094	.018	100	--	8.8
4238	14.47	85.5	10.8	87.7	2.40	none	.084	.018	97	9.2	8.9
4239	16.43	85.8	13.2	86.1	2.05	0.01	.088	.014	88	--	7.5
4243	17.20	88.9	11.7	88.9	1.39	0.10	.074	--	86	9.3	7.8
4244	13.20	84.8	10.3	84.8	1.47	0.06	.081	--	87	9.3	8.0
4245	16.59	82.1	14.1	85.1	2.70	none	*--	--	90	9.2	8.6
4247	14.35	83.8	12.2	85.7	2.60	none	.074	.018	90	--	8.6
4249	17.73	88.9	13.6	89.8	2.17	0.01	*--	--	98	9.8	7.2
4250	14.02	--	9.3	87.6	1.38	0.07	.067	--	94	9.4	8.4
4251	14.98	83.0	11.2	84.7	2.85	none	.089	--	--	8.7	8.0
4252	15.33	83.8	11.7	86.8	1.85	none	.093	--	85	9.0	8.6
4254	16.75	85.3	12.5	86.9	2.33	0.33	.065	.019	83	--	7.4
4259	17.13	86.8	12.6	88.1	2.42	none	.084	--	92	8.8	7.6
4261	16.51	87.5	11.8	89.4	1.42	0.02	.070	.015	95	--	7.6
4266	16.11	88.7	11.4	88.8	2.36	none	.082	.014	85	8.9	8.8
4267	16.80	88.3	14.5	90.5	2.00	0.03	.072	--	--	8.9	8.2
4268	15.86	86.4	11.6	88.1	3.83	0.01	*--	--	96	8.7	8.3
4269	16.25	85.9	13.1	86.2	2.13	0.06	.073	--	90	8.9	7.8
4273	14.59	83.7	11.9	85.1	1.94	0.06	.082	.024	94	--	8.8
4276	15.64	87.2	12.4	88.7	2.07	0.51	*--	--	98	9.2	8.5
4280	13.40	84.9	12.0	86.4	2.43	none	.071	.015	91	--	7.8
4282	13.75	87.9	9.7	87.9	1.22	0.08	.078	--	91	9.4	8.4
4291	15.25	86.7	13.2	86.7	2.70	none	*--	--	95	9.7	9.1
4294	18.28	86.4	15.5	89.3	2.37	0.03	.082	.011	86	8.5	8.2
Average	15.56	--	11.9	87.0	2.07	0.11	0.077	0.016	--	--	--
Avg.1941	15.91	--	12.1	87.2	2.11	0.09	0.081	0.018	--	--	--

* 1st Carbonation pH 4215-10.6, 4245-11.2, 4249-11.0, 4268-10.8
4276-11.0, 4291-10.7

Table 1

PROCESS DATA, STEFFEN

Sample Number	Beets		Diffusion Juice		Lime Used	Soda Ash	Carbonation Alkalinities		2nd Carb'n Temp.	2nd Carb'n pH	Thin [illegible]
	Sucrose	Purity	Brix	Purity	%	lbs.	1st	2nd	C°		
4201	14.76	84.4	11.4	87.6	4.08	0.36	0.088	0.--	98	8.8	8.6
4202	15.82	85.6	12.2	84.7	3.68	1.49	.059	--	91	9.2	9.0
4204	14.71	--	10.6	86.5	4.23	0.37	.061	0.018	96	9.0	9.1
4207	17.17	--	11.9	89.2	2.75	0.27	.064	--	93	9.0	7.9
4209	14.46	82.1	10.7	85.2	4.51	1.39	.075	.008	88	8.5	8.4
4219	13.97	81.3	10.7	82.4	4.41	0.48	.049	--	92	8.6	8.6
4220	17.77	89.1	13.3	89.6	3.07	none	*--	--	88	9.2	8.7
4224	14.20	--	9.4	87.3	3.49	0.06	.074	--	86	9.0	7.7
4226	13.69	--	10.2	85.4	3.20	0.74	.058	--	--	9.1	8.1
4227	13.98	80.2	11.6	82.8	2.93	1.54	.078	.018	100	8.6	8.2
4228	13.10	76.4	11.0	77.9	4.42	0.18	.061	--	85	8.1	7.8
4229	16.47	86.0	12.9	87.6	3.66	none	.068	.016	90	--	8.6
4230	13.38	--	10.1	85.5	2.76	0.08	.067	--	--	9.1	--
4231	13.74	84.0	11.4	85.0	3.63	0.56	.087	.021	95	--	7.9
4237	16.64	88.6	13.6	89.8	3.55	none	.069	--	100	9.3	8.2
4240	16.32	85.8	11.6	87.1	3.42	0.25	.060	.014	97	--	8.3
4241	15.61	--	10.7	87.9	3.03	0.14	.059	.020	89	--	9.2
4242	15.15	--	9.9	88.1	2.99	0.05	.078	--	88	9.2	7.8
4246	13.91	86.1	11.0	86.0	3.90	0.43	.075	.014	98	8.7	7.4
4253	16.43	85.4	10.8	88.1	3.31	0.20	.067	.017	95	8.7	7.8
4255	12.45	78.5	10.3	80.2	4.27	0.53	.062	.017	96	--	8.3
4256	14.71	--	10.5	83.8	2.53	1.08	.070	--	85	9.3	8.0
4257	17.14	84.7	14.5	84.8	5.75	2.64	.079	.017	94	9.2	8.2
4258	13.32	82.6	11.6	83.9	4.50	none	.050	.020	90	--	--
4260	15.23	87.6	11.5	87.7	3.83	0.22	.071	.017	98	9.2	7.8
4262	14.7	86.7	10.9	88.4	5.09	0.05	.083	.013	91	--	8.8
4263	15.15	83.7	10.3	87.6	4.50	1.18	.092	--	97	9.2	9.2
4264	19.79	86.1	15.7	86.5	3.68	1.09	.069	--	--	8.9	8.8
4265	13.94	--	10.3	86.0	3.15	0.15	.064	--	89	9.1	8.0
4270/1	16.20	85.6	12.9	86.9	1.86	none	.067	.016	99	9.0	8.5
4271	17.14	85.9	14.8	87.5	4.14	0.37	*--	--	88	9.1	8.5
4272	13.51	--	9.6	84.4	3.50	0.52	.066	--	86	9.3	8.2
4274/1	16.57	88.5	12.6	89.8	1.93	none	.068	.017	96	9.2	8.1
4275	15.11	82.2	11.3	83.9	4.01	none	.078	--	96	9.4	8.9
4277	13.87	83.6	10.4	85.6	3.92	0.02	.080	--	86	9.2	8.[illegible]
4278	14.62	82.0	12.6	83.2	4.07	1.77	*--	--	87	9.1	9.0
4279	16.49	86.6	12.3	83.8	2.65	none	.076	.013	99	--	8.2
4283	16.61	83.7	12.9	86.9	4.31	0.05	--	--	97	--	--
4284	15.85	88.0	13.7	89.4	3.23	none	.064	--	91	9.3	9.1
4295	17.58	85.4	14.8	87.4	3.29	0.39	.074	.013	94	--	7.9
Average	15.16	--	11.6	86.0	3.73	0.49	0.070	0.016	--	--	--
Avg.1941	15.61	--	12.0	86.3	3.79	0.57	0.073	.017	--	--	--

* 1st Carbonation pH - 4220-11.5, 4271-11.1, 4278-11.2

/1 Operated non-Steffen during 1942, not included in averages.

Table 2

PROCESS DATA, NON-STEFFEN

Sample Number	Thin Juice		Thick Juice			Standard Liquor or Blow-Up			White Massecuite		
	Sulphur lbs.	pH	Sulphur lbs.	pH	Purity	Filtration Brix	Aid lbs.	Temp. C°	Lime Salts	Brix	Purity	pH
4203	0.67	7.8	none	8.8	--	65.8	0.20	90	0.021	90.2	91.6	8.8
4205	0.49	8.5	none	9.2	89.4	69.2	.43	94	.032	91.9	92.0	9.2
4206	0.26	--	none	8.9	90.6	62.6	1.12	97	.033	92.4	93.2	8.8
4208	0.37	8.0	none	9.3	92.8	70.2	0.57	96	.013	91.7	93.4	9.1
4210	0.60	7.8	none	9.0	--	69.8	0.29	88	.018	91.5	91.4	8.9
4211	0.47	8.0	none	9.2	--	68.3	0.23	87	.042	91.5	90.9	9.1
4212	0.78	7.8	none	7.6	91.2	72.0	0.77	89	--	91.7	91.2	7.6
4214	none	8.5	0.19	9.3	90.7	68.1	0.41	95	.026	92.5	92.4	9.3
4215	0.41	8.5	0.05	7.8	89.4	66.8	0.67	93	.085	90.7	93.0	--
4216	0.38	8.1	none	8.8	91.7	68.1	0.43	92	.045	91.0	93.0	8.7
4217	0.43	8.3	none	7.7	92.3	62.4	0.79	86	.047	91.8	94.1	7.7
4218	0.20	8.8	0.29	9.1	91.1	65.5	0.56	96	.044	92.1	92.5	8.4
4222	0.59	8.1	none	--	--	71.2	0.25	93	--	91.8	90.6	9.1
4223	0.12	8.7	0.24	9.1	88.1	68.7	0.52	96	.042	91.7	91.2	8.7
4225	0.49	7.8	0.01	8.8	88.1	70.8	0.27	92	.026	91.1	91.3	8.7
4232	0.41	7.9	none	8.9	--	69.4	0.38	95	.014	91.7	91.7	8.8
4234	0.23	8.7	none	9.3	--	67.1	0.70	86	.057	91.3	94.4	8.9
4235	0.45	8.0	none	9.1	--	68.3	0.35	90	.023	91.2	93.7	9.1
4236	none	8.8	0.43	9.4	88.9	61.1	0.79	95	.056	91.0	92.3	8.4
4238	0.12	8.9	0.20	9.2	90.9	63.0	0.49	97	.099	92.5	91.5	8.2
4239	0.47	7.5	none	8.8	90.4	65.1	0.74	92	.050	92.3	91.5	8.9
4243	0.54	7.8	none	9.0	--	70.9	0.24	92	.006	91.0	92.5	8.9
4244	0.30	8.0	0.17	--	88.4	64.4	0.47	87	--	91.6	91.3	8.8
4245	0.19	8.6	none	8.7	91.6	66.5	0.41	93	.058	91.7	93.6	8.6
4247	0.15	8.6	0.30	8.9	91.3	66.1	0.22	85	.012	91.0	92.5	9.6
4249	0.92	7.2	none	7.7	93.0	63.0	0.79	90	.011	91.5	93.9	7.8
4250	0.58	8.4	none	9.2	--	67.6	0.38	82	.017	90.8	92.2	9.2
4251	0.74	8.0	none	8.1	--	64.7	0.56	--	.107	90.9	91.3	7.8
4252	0.02	8.6	0.09	9.1	96.6	58.0	0.62	90	.006	91.1	92.3	8.1
4254	0.59	7.4	none	7.3	90.2	64.8	0.46	83	--	92.3	91.6	7.2
4259	0.79	7.6	none	8.3	--	66.0	0.51	94	.024	90.8	92.5	7.9
4261	0.56	7.6	none	8.6	91.0	68.3	0.68	95	--	92.4	91.3	8.6
4266	0.15	8.8	0.15	9.6	92.0	63.7	0.57	95	.027	91.4	93.4	9.0
4267	0.28	8.2	none	9.2	92.8	66.5	0.51	94	.036	92.1	93.2	9.0
4268	0.23	8.3	0.34	--	90.1	61.4	0.36	92	.052	90.6	91.5	8.0
4269	0.48	7.8	none	8.0	90.2	70.8	0.40	98	.041	91.3	92.2	8.6
4270	0.29	8.5	none	9.0	90.6	68.9	0.44	95	.032	91.0	92.5	8.7
4273	0.15	8.8	0.33	9.4	89.7	63.8	0.46	95	.057	91.7	91.7	8.8
4274	0.32	8.1	none	9.0	92.3	71.2	0.44	90	.031	91.4	93.5	9.4
4276	0.27	8.5	none	8.7	92.0	68.4	0.51	91	.054	92.5	93.8	8.6
4280	0.37	7.8	none	8.9	89.9	69.2	0.41	94	.043	92.4	90.8	9.0
4282	0.34	8.4	none	8.8	91.8	70.0	0.26	90	.022	91.4	91.7	8.8
4291	0.26	9.1	0.17	8.8	91.6	61.8	none	93	.025	92.2	91.0	8.3
4294	0.32	8.2	0.04	9.3	91.3	67.3	0.26	94	.060	92.0	92.4	9.0
Average	--	8.2	--	8.8	90.9	66.8	0.49	--	0.038	91.5	92.3	8.7
Avg.1941	--	8.2	--	8.7	91.0	67.1	0.44	--	0.034	91.4	92.1	8.4

Average total sulphur used 0.45 lbs., in 1941 0.43 lbs.

Table 2

PROCESS DATA, STEFFEN

Sample Number	Thin Juice		Thick Juice			Standard Liquor or Blow-Up				White Massecuite		
	Sulphur lbs.	pH	Sulphur lbs.	pH	Purity	Filtration Brix	Aid lbs	Temp. C°	Lime Salts	Brix	Purity	pH
4201	0.26	8.6	0.07	8.9	92.7	64.7	0.65	100	0.068	90.4	93.4	8.8
4202	0.24	9.0	none	9.0	88.4	68.3	0.59	70	.055	92.4	94.2	9.1
4204	none	9.1	0.28	9.5	92.7	61.4	0.81	91	.020	91.7	90.9	9.5
4207	0.35	7.9	none	8.8	--	63.5	0.50	92	.031	90.3	93.7	8.8
4209	0.27	8.4	0.02	8.9	89.5	67.1	0.87	90	.073	91.4	90.3	8.5
4219	none	8.6	0.15	8.5	87.8	67.2	0.57	92	.213	91.8	89.2	7.9
4220	0.30	8.7	0.11	9.1	91.8	70.7	0.32	85	.028	91.0	92.9	8.3
4224	0.50	7.7	none	8.3	92.9	68.5	0.72	96	.022	91.6	93.1	--
4226	0.45	8.1	none	8.8	90.6	70.4	0.45	92	.025	90.4	90.8	8.9
4227	0.40	8.2	none	9.1	87.7	62.8	0.77	97	.058	90.7	91.6	8.9
4228	none	7.8	0.30	9.0	86.4	63.1	0.53	90	.148	91.1	87.5	8.2
4229	0.24	8.6	none	8.8	92.7	67.6	1.15	93	.035	91.2	93.6	8.5
4230	0.55	--	none	8.8	--	71.9	0.54	86	--	90.1	90.6	8.8
4231	0.70	7.9	none	--	90.3	69.3	0.52	--	--	90.5	92.6	7.7
4237	0.32	8.2	none	8.2	92.6	68.0	0.43	92	.051	91.2	93.0	8.3
4240	0.27	8.3	none	8.3	91.4	65.6	0.71	81	.038	91.8	90.5	8.0
4241	0.32	9.2	none	8.1	--	69.6	0.49	95	--	90.6	92.5	8.1
4242	0.32	7.8	none	8.8	92.4	69.6	0.47	99	.028	90.8	92.3	8.6
4246	0.40	7.4	0.27	7.3	90.1	69.4	0.47	91	.075	90.4	92.0	8.1
4253	0.34	7.8	none	8.2	92.7	68.6	0.75	89	--	91.7	94.3	8.4
4255	0.29	8.3	none	8.1	86.0	68.5	0.85	92	.217	92.0	88.7	7.7
4256	0.74	8.0	none	8.7	--	68.5	0.84	94	--	91.8	90.8	8.8
4257	0.54	8.2	none	7.4	89.3	66.7	0.61	94	.059	90.7	92.4	7.4
4258	none	--	0.25	8.2	90.2	60.0	0.75	90	.090	92.0	91.0	7.8
4260	0.51	7.8	none	7.9	92.0	67.9	0.50	88	.037	90.6	94.4	7.9
4262	0.20	8.8	0.30	9.8	92.7	60.9	0.86	97	.021	91.7	93.2	8.5
4263	none	9.2	0.26	9.2	91.6	65.8	0.98	96	.030	92.3	93.0	8.7
4264	0.40	8.8	none	7.6	90.1	66.7	0.74	97	.093	90.7	93.7	7.3
4265	0.33	8.0	none	8.9	--	70.1	0.58	91	--	89.2	92.1	8.8
4271	0.21	8.5	none	8.1	91.8	68.1	0.60	99	.162	91.2	94.6	7.9
4272	0.52	8.2	none	8.2	--	--	0.82	91	--	91.6	90.7	8.2
4275	0.33	8.9	0.01	8.7	91.3	64.9	0.26	86	.061	90.7	92.8	8.5
4277	0.31	8.1	none	8.9	90.6	69.0	0.30	94	.026	90.7	92.5	8.9
4278	0.30	9.0	none	--	87.5	58.2	0.57	92	.069	91.9	91.6	8.9
4279	0.39	8.2	none	8.5	91.6	57.9	0.95	94	.055	90.6	92.4	8.5
4283	0.23	--	none	--	90.2	60.8	0.44	90	.106	91.7	93.1	7.5
4284	0.12	9.1	0.31	9.1	92.5	65.2	0.46	99	.042	91.3	92.4	7.9
4295	0.40	7.9	0.06	7.7	90.0	65.3	0.46	96	.063	90.6	89.0	7.1
Average	--	8.4	--	8.6	90.6	66.3	0.63	--	.068	91.1	92.1	8.3
Avg.1941	--	8.4	--	8.4	90.7	67.3	0.57	--	.059	91.0	92.4	8.1

Average total sulphur used 0.38 lbs. per ton; in 1941 0.37 lbs.

Table 3

PROCESS DATA, NON-STEFFEN

Sample Number	White Massecuite				White sugar as sacked		High Green		High Wash	
	Cu. Ft. per 100 lbs sug.	Wash Water Temp. C°	Wash Water per mach. qts.	Wash Water per 100 sug qts.	Temp. C°	Moist. %	Brix	Purity	Brix	Purity
4203	3.28	90	15	3.7	39	0.026	77.1	84.4	--	--
4205	3.04	96	17	6.8	39	.036	*69.4	87.1	--	--
4206	2.55	130	10	--	37	.023	80.9	87.1	--	[illegible]
4208	3.19	97	18	7.0	47	.037	70.0	88.1	--	91.[illegible]
4210	3.23	91	18	4.0	34	.010	78.1	84.0	80.0	89.[illegible]
4211	2.58	89	16	5.0	39	.017	73.2	82.6	--	89.6
4212	2.80	94	15	5.0	71	.030	75.8	84.2	--	88.[illegible]
4214	3.02	100	18	8.0	46	.033	75.6	86.1	--	91.[illegible]
4215	2.88	110	16	4.4	52	.038	76.0	86.9	75.3	94.4
4216	3.00	108	11	2.4	48	.032	70.8	87.4	71.2	91.4
4217	3.10	94	17	6.0	46	.024	74.0	88.9	71.4	93.9
4218	2.71	120	15	4.0	44	.012	66.6	84.7	73.9	94.2
4222	3.29	94	16	6.6	39	.026	74.4	82.7	--	90.0
4223	2.84	96	16	6.5	50	.029	82.0	84.6	84.0	92.5
4225	3.06	96	17	7.4	41	.021	77.3	83.4	--	90.2
4232	3.05	91	17	2.6	31	.016	72.1	83.8	--	9[illegible]
4234	3.09	92	16	6.9	50	.029	--	89.9	--	95.5
4235	2.67	96	13	4.0	55	.038	76.0	88.0	70.0	92.6
4236	2.98	91	17	--	57	.030	--	85.2	--	91.7
4238	2.95	88	14	5.4	48	.032	71.3	83.6	73.4	89.5
4239	2.89	95	16	4.3	67	.043	64.7	84.8	66.2	90.3
4243	3.10	92	18	6.0	44	.026	76.2	87.2	73.7	90.5
4244	2.93	94	17	6.0	44	.013	76.3	82.4	71.3	91.3
4245	2.99	94	14	6.0	50	.022	76.8	86.9	--	91.9
4247	2.44	104	17	--	36	.012	65.0	83.9	68.0	91.0
4249	2.82	90	18	6.0	56	.030	78.3	88.0	75.9	93.0
4250	3.09	94	17	--	39	.021	77.3	85.0	74.8	92.2
4251	3.40	82	--	--	74	.040	--	85.6	--	91.7
4252	2.70	95	16	3.5	50	.030	83.1	84.5	--	89.5
4254	2.44	91	13	3.3	63	.036	75.9	83.9	--	91.0
4259	2.79	88	14	4.1	50	.038	--	85.1	--	92.1
4261	2.63	94	14.5	4.1	44	.018	71.2	83.3	--	91.2
4266	2.70	125	14	3.7	50	.031	71.1	86.4	75.5	[illegible]
4267	2.76	91	18	6.0	53	.019	67.8	87.6	--	[illegible]
4268	3.18	90	18	7.0	59	.046	--	85.4	--	89.[illegible]
4269	3.00	95	16	5.0	53	.028	82.0	86.4	75.2	90.8
4270	3.38	97	13	4.9	34	.053	75.2	85.7	--	89.9
4273	2.98	97	16	6.0	37	.031	80.3	84.8	78.9	91.2
4274	2.99	98	17	6.3	40	.051	71.5	88.2	71.3	91.7
4276	2.85	100	14	4.7	44	.028	68.2	87.9	--	95.7
4280	3.00	93	17	7.3	55	.037	75.5	83.6	--	[illegible]
4282	2.85	90	17	6.5	33	.024	71.6	84.2	--	90.[illegible]
4291	2.59	80	17	5.3	52	.040	79.6	78.3	70.9	85.7
4294	2.85	93	17	5.5	35	.022	82.5	84.0	76.8	93.7
Average	2.93	--	15.8	5.3	--	0.029	--	85.6	--	91.5
Avg.1941	2.71	--	16.2	5.7	--	0.026	--	85.3	--	91.3

* Green and wash mixed.

Table 3

PROCESS DATA, STEFFEN

Sample Number	White Massecuite				White sugar as sacked		High Green		High Wash	
	Cu. Ft. per 100 sugar	Wash Water Temp. C°	Wash Water Qts. per mach.	Wash Water Qts. per 100 sug.	Temp. C°	Moist. %	Brix	Purity	Brix	Purity
4201	3.35	85	16	6.4	48	0.037	59.1	87.9	68.2	91.6
4202	3.06	95	14	4.8	44	0.017	83.7	88.6	--	94.8
4204	2.55	106	7.2	2.1	51	0.031	60.6	81.1	60.8	87.7
4207	3.39	90	16	6.4	45	0.027	79.0	88.8	77.0	92.0
4209	3.41	93	17	--	59	.056	--	83.9	--	89.6
4219	2.66	90	--	--	48	.040	--	80.2	--	83.8
4220	2.88	94	17	6.1	54	.026	80.3	86.6	78.1	90.5
4224	2.97	91	15	5.0	32	.022	79.2	87.4	--	92.1
4226	3.50	--	18	--	30	.023	77.2	83.6	72.4	89.9
4227	2.35	98	17.5	6.0	50	.034	65.0	85.0	65.0	91.0
4228	3.50	90	17	6.9	38	.048	80.6	79.7	75.4	86.7
4229	3.69	114	16	5.2	35	.030	72.2	87.8	--	93.0
4230	3.30	87	15	5.5	42	.030	81.4	84.9	80.4	88.5
4231	3.01	100	17	5.7	57	.043	74.8	85.9	70.1	91.5
4237	3.46	114	12	4.0	39	.023	70.2	87.6	75.0	92.2
4240	3.22	90	16	8.6	57	.034	74.8	84.7	78.0	87.7
4241	3.18	96	18	7.1	44	.026	76.9	84.8	--	90.6
4242	3.08	90	18	--	43	.025	78.5	85.9	73.7	91.0
4246	3.49	96	15	--	47	.045	80.3	85.4	76.2	91.5
4253	2.87	96	17	--	55	.021	71.0	87.4	--	94.8
4255	3.07	80	16	5.5	51	.039	82.2	82.1	80.9	90.7
4256	3.17	93	14	5.5	36	.016	72.8	82.8	--	91.3
4257	3.27	93	17	4.9	51	.040	75.6	87.3	--	95.9
4258	--	90	16	5.0	--	--	--	84.0	--	89.5
4260	3.09	117	16	--	43	.040	71.7	88.1	70.7	94.5
4262	3.01	--	8	3.2	47	.042	82.3	86.4	75.4	91.5
4263	3.39	98	17	5.7	60	.035	83.8	87.3	--	91.4
4264	2.77	95	14	4.8	47	.034	--	84.2	--	92.3
4265	3.00	88	18	6.6	39	.032	76.7	86.6	--	90.3
4271	3.33	85	15.3	5.7	45	.033	74.8	89.5	--	--
4272	3.30	89	14	5.7	49	.019	75.8	83.5	73.1	88.8
4275	3.46	96	14	6.6	50	.028	73.4	85.6	84.5	91.8
4277	2.68	96	15	4.9	60	.035	81.6	86.7	79.6	91.3
4278	3.17	96	16	4.0	42	.030	82.0	84.1	84.2	90.6
4279	2.90	93	14	--	37	.031	70.4	86.7	--	90.9
4283	2.72	100	19.6	4.8	26	.027	*72.3	87.6	--	--
4284	2.94	94	16	4.5	55	.024	82.1	85.9	76.3	90.6
4295	3.32	95	18.4	7.0	50	.032	82.9	79.9	79.1	87.4
Average	3.12	--	15.5	5.4	--	0.032	--	85.6	--	90.9
Avg.1941	3.05	--	15.8	5.6	--	0.034	--	84.9	--	90.7

* Green and Wash mixed.

Table 4

PROCESS DATA, NON-STEFFEN

Sample Number	High Raw Massecuite Brix	Purity	Cu. Ft. per 100 wht. sug.	High Raw Sugar Purity	Low Raw Massecuite Brix	Purity	Cu. Ft. per 100 wht. sug.	Low Raw Sugar Purity	Carbon used per 100 wht. sugar lbs.
4203	92.5	82.0	1.50	97.5	97.4	73.6	0.60	93.2	none
4205	93.1	85.4	2.16	97.6	96.2	75.3	0.78	90.7	0.09
4206	93.4	86.3	1.99	98.4	95.8	75.5	0.61	93.0	.05
4208	93.3	85.3	1.63	98.0	95.1	75.2	0.49	91.2	.06
4210	94.2	81.3	1.37	97.6	97.4	72.4	0.46	85.0	none
4211	95.2	82.6	1.59	96.8	98.4	72.0	0.74	88.4	none
4212	94.9	84.7	0.94	96.8	95.8	73.1	0.43	90.6	.11
4214	93.9	83.9	1.46	98.3	95.8	75.8	0.69	91.6	none
4215	91.6	86.5	1.67	99.3	92.8	77.2	1.06	93.9	.16
4216	93.2	84.3	1.71	98.0	94.2	72.6	0.53	91.3	.02
4217	92.6	80.0	1.31	99.4	94.1	77.8	0.60	97.2	.17
4218	92.8	84.6	0.94	97.4	93.9	75.8	0.63	93.4	.19
4222	93.3	81.7	1.61	92.6	98.2	72.5	0.59	89.8	none
4223	93.4	85.0	1.38	97.[illegible]	94.2	74.8	0.79	91.8	.26
4225	93.2	81.5	1.10	--	97.7	72.1	0.50	--	none
4232	93.2	83.9	1.15	98.8	96.8	73.5	0.61	88.3	none
4234	92.9	89.1	2.51	98.8	94.9	80.6	0.90	93.9	.12
4235	93.2	86.9	1.94	98.7	94.8	76.7	0.64	88.9	.05
4236	91.6	86.3	2.13	97.9	93.3	75.4	0.82	92.7	.22
4238	91.4	83.7	0.87	98.7	93.4	76.6	0.66	96.8	none
4239	93.9	84.9	0.93	97.5	95.4	73.2	0.50	92.1	.11
4243	94.2	85.6	1.31	97.9	96.7	74.5	0.45	89.4	none
4244	94.0	82.4	1.62	97.5	99.0	72.8	0.75	88.7	.10
4245	92.1	88.2	1.35	98.1	92.9	79.9	0.74	97.4	none
4247	91.1	85.0	--	98.7	92.7	77.1	--	95.8	.22
4249	91.6	86.6	1.20	98.3	92.7	77.5	0.49	94.0	.14
4250	91.6	91.6	1.60	98.7	97.0	73.2	0.57	91.3	none
4251	91.3	85.6	1.55	95.7	93.9	76.9	0.95	92.0	none
4252	*83.1	84.5	--	96.5	89.9	78.9	--	92.2	none
4254	92.7	83.7	1.25	96.5	95.3	73.9	0.50	89.8	.08
4259	92.8	85.4	0.89	97.6	96.8	73.3	0.44	92.2	none
4261	93.6	83.0	0.85	95.7	97.5	71.4	0.43	87.9	.08
4266	91.0	83.3	1.27	96.8	94.3	75.8	0.46	94.0	.21
4267	93.2	84.8	1.47	97.3	94.4	75.1	0.42	91.8	.05
4268	91.0	84.5	1.56	96.4	93.0	75.5	0.71	89.0	.07
4269	91.3	85.3	1.43	97.4	94.3	76.5	0.62	94.4	.09
4270	93.1	84.7	1.91	96.4	95.5	74.0	0.56	92.6	none
4273	94.0	84.4	1.37	99.0	97.8	74.6	0.78	92.6	.21
4274	92.9	84.7	1.77	97.1	94.7	75.1	0.40	91.9	.09
4276	93.7	85.6	1.35	98.2	93.2	74.8	0.47	92.2	.13
4280	94.8	84.1	1.28	95.4	96.6	75.4	0.82	87.4	.09
4282	94.3	81.8	1.16	97.3	97.3	72.3	0.52	91.2	none
4291	*--	--	--	--	95.8	79.8	0.65	95.6	.15
4294	86.6	84.9	0.89	98.2	94.6	75.9	0.57	93.3	none
Average	92.9	84.7	1.46	97.5	95.3	75.0	0.62	91.7	0.08
Avg.1941	92.9	84.7	1.43	97.6	95.2	74.5	0.68	91.4	0.08

* Cold crystallization.

Table 4

PROCESS DATA, STEFFEN

Sample Number	High Raw Massecuite Brix	Purity	Cu. Ft. per 100 wht. sug.	High Raw Sugar Purity	Low Raw Massecuite Brix	Purity	Cu. Ft. per 100 wht. sug	Low Raw Sugar Purity	Carbon used per 100 wht sug.	Molasses worked % beets
4201	89.3	87.7	1.04	97.7	90.5	82.9	0.33	97.1	0.14	4.46
4202	93.6	87.1	2.09	99.2	95.4	76.6	0.80	93.6	.14	6.69
4204	*--	--	--	--	92.0	81.1	0.68	95.6	none	3.24
4207	92.2	85.9	1.56	96.4	92.4	77.6	0.49	90.6	.12	4.70
4209	90.9	83.3	1.03	95.9	90.6	77.9	0.99	93.7	.18	6.89
4219	92.3	82.3	1.25	97.7	92.1	73.3	0.95	94.1	.12	5.73
4220	91.0	86.7	0.96	97.8	92.9	78.0	0.49	95.7	.03	3.14
4224	90.7	80.7	1.42	96.0	93.0	78.5	0.66	92.0	none	5.71
4226	91.6	82.7	1.90	96.0	94.9	73.9	--	84.2	none	5.93
4227	90.7	86.8	1.85	98.5	92.1	77.2	0.87	96.2	.73	4.65
4228	87.0	80.9	--	96.9	93.0	76.2	--	94.9	.20	7.77
4229	93.2	86.6	--	97.3	93.7	77.6	0.19	94.7	none	6.66
4230	91.2	85.3	1.10	96.7	95.8	78.3	0.30	90.7	none	5.41
4231	90.9	87.2	1.00	99.5	91.6	79.0	1.04	94.4	.23	5.48
4237	91.9	86.4	1.36	98.0	93.6	78.8	0.59	92.8	none	5.82
4240	92.4	84.3	1.07	97.7	93.1	75.5	0.54	91.3	.14	5.76
4241	90.9	84.8	1.50	97.1	92.7	76.9	0.62	88.4	none	5.82
4242	91.0	84.5	1.49	95.6	92.3	77.4	0.65	90.1	none	5.65
4246	91.3	86.1	1.26	99.1	91.8	77.6	0.93	92.5	.15	7.77
4253	92.2	88.0	1.19	98.7	93.4	79.6	0.56	90.7	.33	3.65
4255	91.9	83.8	1.86	98.3	93.0	75.3	1.34	94.3	none	7.22
4256	92.9	81.7	2.05	96.9	97.0	72.5	0.80	87.6	.09	4.50
4257	92.2	86.9	2.06	98.6	91.5	76.5	1.04	93.3	.11	10.09
4258	91.5	84.5	--	97.0	93.0	76.0	--	95.0	.40	5.80
4260	90.6	88.5	1.44	99.4	91.7	79.7	0.76	95.7	.19	5.54
4262	90.8	85.6	2.30	98.3	90.8	78.9	0.88	96.2	.17	4.28
4263	83.8	87.3	1.64	97.9	92.3	79.6	0.85	94.2	.15	6.41
4264	91.9	86.2	2.34	98.0	94.6	75.8	0.70	93.6	.10	4.43
4265	91.1	84.9	2.20	96.1	94.1	75.5	0.90	88.6	none	5.33
4271	91.5	88.4	1.02	98.6	92.3	79.9	0.82	97.3	none	7.12
4272	90.8	81.7	1.50	98.6	95.6	75.0	0.79	94.5	.01	6.50
4275	92.3	85.4	1.54	98.4	94.9	75.7	0.78	95.4	.11	5.57
4277	92.4	86.6	1.40	97.3	93.2	77.2	0.70	92.2	.09	6.52
4278	93.5	85.9	2.20	97.1	94.9	77.4	1.08	93.7	.16	7.24
4279	91.4	85.3	1.40	96.0	93.2	77.7	0.50	93.0	.10	4.52
4283	93.5	86.1	1.28	98.4	92.3	79.6	0.81	97.2	none	5.98
4284	90.1	86.2	1.20	95.7	91.2	77.8	0.63	90.9	.03	5.65
4295	92.2	81.1	0.24	97.9	92.3	77.6	0.89	92.5	.03	5.37
Average	91.3	85.3	1.62	97.6	93.0	77.4	0.76	93.2	0.11	5.77
Avg.1941	91.3	85.8	1.62	97.7	93.0	77.3	0.86	93.6	0.14	5.99

* Cold Crystallization

OPERATING DATA

1. Quality of Beets and Diffusion Juices

In most areas the sucrose content of the beets was lower than in the 1941 campaign. This lower sucrose was evident at about 70% of the factories. In extreme cases the drop below the 1941 level was by more then 3% sucrose on beets. At one third of the factories having beets with a lower sucrose content the purity of the diffusion juices was as good or better than for the previous year. It is possible that in these instances the low sucrose value was partly due to a relatively wet harvest period. Early freezes followed by growing weather were responsible for part of the low sucrose beets where accompanied by a lower juice purity.

The higher sucrose in the beets at some factories may have been due to the beets being lower in moisture content as the purities of the juices were unchanged or lower than in 1941. At one half of the factories, where the sucrose on beets was higher then the previous year, the diffusion juice purities also increased, indicating a better beet maturity.

2. Liming and Carbonation

The amount of lime used (% on beets) remained essentially unchanged. The use of soda ash at non-Steffen factories increased slightly on the average, but at the Steffen factories there was a further decrease continuing the trend evident in 1941. The alkalinities after first carbonation averaged lower than previously. The average pH or alkalinity after second carbonation was unchanged at a value of 9.0 pH.

3. Sulphuring

Seven factories sulphured thick juice only, sixteen sulphured both thin and thick juices and the remainder sulphured only thin juice. The total sulphur used averaged the same as in 1941 and the final pH of thin juice was also unchanged. However, the pH of the thick juices averaged slightly higher than usual indicating a tendency for the pH to increase more during evaporation of the thin

juices. Sixty-two percent of the non-Steffen factories used over 0.4 lbs. of sulphur per ton of beets while only 32% of the Steffen factories exceeded this figure.

4. pH Change from Thin Juice to Thick Juice

The greater tendency for the pH of non-Steffen thin juices to increase considerably during evaporation to thick juices, than is the case with Steffen thin juices, is again evident. This explains the need of the higher sulphuring used on non-Steffen juices. The increase in pH is especially pronounced at the non-Steffen factories of areas No. 3 and No. 4 (see table No. 9); even the Steffen juices show some increase in pH in these areas. Considering them individually, only four non-Steffen thin juices fail to show an increase in pH during evaporation while 14 Steffen thin juices remain constant or decrease in pH. The average increase for non-Steffen juices was by 0.8 pH units and for Steffen juices the average increase is only 0.2 pH units.

The average temperature of second carbonation was 1° C. higher for Steffen factories than for non-Steffen; the number of factories reporting temperatures below 90° C. was twelve in each group and the number reporting temperatures above 95° C. was also equal. It does not seem entirely satisfactory to explain the difference in behavior between non-Steffen and Steffen juices solely on the basis of differences in bicarbonates, rather, in part at least, it is a result of differing non-sugar composition.

5. Standard Liquor and White Massecuite

The average density for the filtration of standard liquor and blow-ups shows some decrease while the use of filter-aid shows an increase. This is contrary to the trend of recent years. Only 15% of the factories filtered at 70° Brix or over but 54% reported densities between 65° and 70°. Double filtration was used at 40% of the factories and 30% now use top discharge filters or the equivalent.

Non-Steffen white massecuite purities show a slight average increase and Steffen massecuites a similar decrease. Fifty-seven percent of the non-Steffen

and 62% of the Steffen white massecuites exceed 92% purity. The corresponding proportions for 1941 were 47% and 65% respectively. The higher massecuite purities at non-Steffen factories in area no. 1 (see table no. 9) were mainly responsible for the increase in the general average. In the case of Steffen massecuites areas nos.1, 2, and 3 showed a decrease in purity.

The cu. ft. of white massecuite yielding 100 lbs. of white sugar was reported more completely this year and indicates a smaller average yield of sugar per cu. ft. than estimated last year. Again a wide variation between factories may be seen as the yield per cu. ft. ranged from 29 to 41 lbs.

6. Washing of White Sugar

The increased use of high temperature wash water and superheated water within the past two years is striking. In 1940 only three factories used water at a temperature of 100° C or over. This past year 14 factories used this improved operating condition. The use of high-speed centrifugals increased almost as much. The amount of water used has remained rather constant on the average although there is a small decrease this year when compared with 1941.

Both high wash and high green purities increased. The difference between high green and diffusion juice purities decreased indicating perhaps an increase in the amount of sugars remelted.

7. Raw Massecuites and Remelt Sugars

High and low raw massecuites and sugars differed very little in purities from the averages for 1941. While the average high raw sugar purities at non-Steffen and Steffen factories are equal, in the case of low raw sugars the purities average notably higher at the Steffen factories.

Nearly complete data were reported on the cu. ft. of raw massecuites per 100 lbs. of white sugar. The range for the high raw massecuite was from 0.87 up to 2.09 cu. ft. and for the low raw massecuite from 0.40 to 1.34 cu. ft. The averages are highest for the Steffen factories.

8. Use of Activated Carbon

The use of decolorizing carbons has not increased but has been continued at about two thirds of the factories. The average amounts shown in the tables are the averages based on all the factories. The average amounts used at the factories actually using carbon are 0.12 lbs. per 100 of white sugar at non-Steffen factories and 0.17 lbs. at Steffen factories.

9. Storage of Beets

Approximately three million tons of beets were stored in piles for thirty days or more; this is about 26% of the beets sliced. The losses of beets were unusually heavy in some areas partly because of frozen beets. Ignoring losses of this special character it is possible that the sugar loss in stored beets sliced may have amounted to well over 20,000 tons of sugar.

Experimental work carried on shows that no appreciable inversion of sucrose occurs except when spoilage is present. Even under conditions of extreme drying with weight losses as high as 35% there is still no significant increase in reducing sugars on the original weight basis. As this work was carried out at temperatures below 60° F, it still remains a possibility that at higher temperatures inversion may be found. At present it may be assumed that the losses of sucrose are due to respiration of the sound beets and the sucrose inversion and destruction which occurs in decaying beets.

Even slight spoilage seems to produce very significant inversion, small spots of decay increase the reducing sugar content of the whole beet markedly. Reducing sugar determinations made on diffusion juice a few times during the early part of a campaign may be used as a basis for comparison with determinations made while slicing piled beets. The indication of even small increases such as 0.1% reducing sugars on juice will usually signify some degree of spoilage in the beets.

The losses of sucrose, presumably through respiration, seem strikingly

higher in exposed beets. These beets on the outside of the piles are subjected to drying, higher temperatures and a more rapid circulation of air. Which of these three factors is most important in causing the larger sucrose loss is not fully shown by the experiments to date. The influence of temperature is well established. However, in sprinkling experiments where the surface beets were kept near the temperature of the interior of the pile and moisture losses were entirely prevented, the surface beets still lost sucrose to a greater extent than the beets inside the pile. This leads to the thought that perhaps exposure to sunlight or rate of circulation of air may be factors in respiration.

Sound beets in the interior of the piles lose sucrose at a minimum rate that probably is not much more than one quarter of the loss in the surface beets. It appears, tentatively, that precoating the surface beets reduces sugar losses significantly but on protected beets inside the piles no beneficial effects are found.

A satisfactory technique for sampling beets and preparing the sample for analysis, which is applicable to both withered beets and fresh beets on an equal basis, has not been found. It is one of the primary problems in obtaining the true picture of the changes which occur and it is quite possible that conclusions will need revising when this problem is solved. Sampling with the usual beet rasp is very irregular when differences of turgidity and moisture content are involved. As moisture content decreases more and more material is lost and the pulp made builds up more and more along the sides of the cut on the beet. When the moisture content is considerably reduced the pulp made collects entirely on the beet, none on the shield, and much material is scattered and lost.

Examination of numerous storage piles indicates that insipient spoilage is a very important factor is determining the total sucrose lost. In fact, it is responsible for more loss than is respiration. Like respiration, spoilage is much increased by higher temperatures. Keeping trash out of beets going into the piles is most important in ensuring that heat formed by respiration and

incidental spoilage can freely escape.

10. Summary

As seen in the operating data which has been reported there has been little change in the average control figures. Considering the adverse operating conditions this is an accomplishment. Improvements in equipment were largely at the centrifugal station where the use of superheated water and high speed centrifugals has increased. Double filtration of standard liquor and top discharge filters are also becoming more widely used.

STUDIES OF THE SUGARS

The usual analysis of the sugars were made except that time did not permit the making of the barley candies. This was not omitted because it was thought unimportant and will be included again next year.

It should be pointed out that the average values given in the tables do not include sugars 4290, 4291, 4294, and 4295. Where there are (a) and (b) samples the values for the two samples were averaged before including in the general averages.

1. Ash Content of Sugars

The carbonate ash values on the average increased to about the level of the 1939 sugars. Only seven percent of the sugars were below 0.0075% ash and 55% were over 0.0100% ash. This increase in ash was rather general, the sugars of only 16% of the factories showed an ash below 1941 values. The average increase is only twenty parts per million and is partly due to lower white pan purities. As will be seen when considering ash constituents, the increase in ash is largely derived from an increased content of organic salts, which may be a seasonal effect associated with the lower sucrose in beets. The non-sugar composition of the beets rather directly affects the composition of the white massecuite and the sugars produced. If it were not for the variable work done in sugar boiling and washing,

Table 5

ASH, SALTS AND MINERAL COMPOSITION, NON-STEFFEN

Sample Number	Carbonate Ash %	Sulphated Ash %	Specific Conductivity X 10^6	Mineral Constituents SO_2 ppm	SO_3 ppm	Cl ppm	CaO ppm	SiO_2 ppm	Est'd. Org.Acd. (combined) ppm	Estimated Salts Total % sug.	Inorg. % tot.	Org. % tot.
4203	0.0079	0.0098	17.8	8	11	3	2	0	42	0.0110	44.2	55.8
4205	.0118	.0136	27.1	3	11	4	6	6	86	.0160	25.9	74.1
4206	.0104	.0130	24.9	3	4	3	6	6	104	.0170	15.3	84.7
4208	.0108	.0122	23.2	3	4	6	3	4	90	.0155	19.7	80.3
4210	.0082	.0102	18.7	4	7	4	2	0	56	.0121	28.3	71.7
4211	.0114	.0136	26.2	3	13	13	3	10	60	.0154	35.7	64.3
4212	.0188	.0220	40.7	4	19	7	5	0	150	.0276	22.7	77.3
4214	.0090	.0118	24.0	1	4	10	2	0	74	.0144	21.9	78.1
4215	.0084	.0108	19.8	8	5	5	7	0	58	.0125	32.6	67.4
4216	.0084	.0109	18.3	3	5	3	5	6	70	.0135	22.3	77.7
4217	.0067	.0084	13.0	6	5	6	5	11	40	.0095	45.5	54.5
4218	.0124	.0160	29.0	4	7	4	6	0	108	.0199	17.0	83.0
4221	.0088	.0112	18.5	11	7	6	4	4	44	.0121	47.2	52.8
4222	.0110	.0134	27.3	4	17	9	3	8	64	.0155	43.6	56.4
4223	.0137	.0171	30.4	5	10	4	3	1	114	.0213	20.1	79.9
4225	.0092	.0110	23.1	8	7	7	5	0	58	.0127	36.5	63.5
4232	.0088	.0101	20.0	4	8	4	3	0	60	.0122	28.0	72.0
4234	.0076	.0095	18.3	1	7	6	9	0	62	.0118	23.8	76.2
4235	.0124	.0144	30.5	4	10	7	4	4	94	.0178	26.6	73.4
4236	.0090	.0118	21.1	6	12	2	6	4	62	.0137	34.5	65.5
4238	.0086	.0110	20.6	2	5	2	6	0	90	.0144	13.0	87.0
4239	.0140	.0180	33.0	3	12	14	9	0	104	.0218	28.5	71.5
4243	.0090	.0106	21.7	4	11	4	1	14	60	.0126	37.5	62.5
4244A	.0082	.0090	16.8	4	5	7	3	10	52	.0107	37.1	62.9
4244B	.0078	.0090	19.3	2	7	5	3	16	58	.0110	34.1	65.9
4245	.0064	.0080	16.5	2	6	7	7	0	44	.0095	33.4	66.6
4247	.0088	.0102	17.8	1	0	2	4	0	92	.0138	3.5	96.5
4249	.0102	.0114	22.3	20	16	3	2	0	24	.0114	71.4	28.6
4250	.0074	.0083	14.6	4	4	5	3	0	44	.0097	31.3	68.7
4251	.0106	.0134	23.3	5	14	5	7	12	74	.0160	37.3	62.7
4252	.0117	.0148	24.0	9	21	4	8	29	48	.0161	59.3	40.7
4254	.0102	.0122	22.2	19	6	5	4	4	30	.0122	62.5	37.5
4259	.0120	.0146	27.0	27	13	9	3	8	2	.0129	97.6	2.4
4261	.0116	.0136	25.3	17	21	12	3	12	6	.0126	93.3	6.7
4266A	.0076	.0086	15.7	3	2	3	3	1	68	.0110	14.9	85.1
4266B	.0077	.0090	14.8	2	3	2	4	0	66	.0114	14.0	86.0
4267	.0086	.0100	19.0	2	5	2	4	3	72	.0127	18.6	81.4
4269	.0084	.0108	20.0	7	5	3	3	10	66	.0131	30.8	69.2
4270	.0136	.0166	30.1	3	13	13	7	6	94	.0198	32.6	67.4
4273	.0114	.0138	27.2	9	9	10	7	0	72	.0159	36.9	63.1
4274	.0112	.0128	24.0	4	7	5	3	0	82	.0157	22.7	77.3
4276	.0060	.0068	13.0	3	6	4	4	0	32	.0078	36.9	63.1
4280	.0092	.0107	18.8	2	8	9	6	5	60	.0127	33.9	66.1
4282	.0084	.0098	21.6	7	7	10	2	10	44	.0109	48.9	51.1
4291	.0146	.0178	33.0	8	10	7	7	6	112	.0217	27.3	72.7
4294	.0098	.0115	29.7	5	5	5	8	1	72	.0139	24.5	75.5
Average	0.0100	0.0120	22.6	6	9	6	4.5	4.5	66	0.0142	34.3	65.7
Avg.1941	.0085	0.0111	22.3	9	8	5	5	6	53	0.0132	42.0	58.0

Table 5

ASH, SALTS AND MINERAL COMPOSITION, STEFFEN

Sample Number	Carbonate Ash %	Sulphated Ash %	Specific Conductivity λ 10^5	Mineral Constituents SO_4 ppm	BO_3 ppm	Cl ppm	CaO ppm	SiO_2 ppm	Est'd. Org. Acid (combined) ppm	Estimated Salts Total % on sugar	Inorg. % of tot.	Org. % of tot.
4201	0.0090	0.0109	19.6	2	7	5	5	1	70	0.0134	23.4	76.6
4202	.0087	.0110	20.8	2	4	6	8	0	76	.0137	19.2	80.8
4204	.0170	.0208	38.6	5	12	5	3	8	144	.0252	20.9	79.1
4207	.0085	.0098	20.0	4	9	2	2	2	62	.0120	28.0	72.0
4209	.0169	.0194	35.8	9	4	3	6	2	156	.0251	14.3	85.7
4219	.0197	.0252	42.0	5	14	3	16	19	186	.0323	19.6	80.4
4220	.0097	.0120	26.7	9	8	6	4	0	60	.0138	36.7	63.3
4224	.0136	.0166	31.3	12	8	13	4	0	80	.0187	38.2	61.8
4226	.0118	.0152	27.8	3	13	10	5	2	86	.0181	31.1	68.9
4227	.0147	.0174	29.9	2	7	2	8	8	142	.0229	13.1	86.9
4228	.0178	.0226	42.3	2	11	23	8	4	132	.0270	29.1	70.9
4229	.0098	.0122	21.3	2	7	10	6	4	72	.0146	29.5	70.5
4230	.0152	.0182	35.5	12	12	6	3	4	102	.0215	32.4	67.6
4231	.0136	.0164	28.6	12	10	7	6	2	88	.0191	34.6	65.4
4237	.0144	.0174	33.8	7	12	3	5	4	112	.0215	24.0	76.0
4240	.0148	.0186	34.8	11	7	10	8	0	114	.0223	27.0	73.0
4241	.0116	.0144	25.8	6	7	2	4	4	98	.0179	20.6	79.4
4242	.0118	.0148	24.8	6	2	3	2	6	120	.0192	14.7	85.3
4246	.0090	.0103	19.0	3	5	2	4	0	80	.0133	15.5	84.5
4253	.0038	.0096	18.5	6	4	2	3	6	60	.0117	27.5	72.5
4256	.0135	.0162	30.2	2	7	1	10	6	134	.0214	12.3	87.7
4256A	.0100	.0112	23.5	8	9	7	3	10	54	.0128	44.6	55.4
4256B	.0096	.0109	21.7	7	9	7	2	10	50	.0124	44.3	55.7
4257	.0082	.0097	18.0	4	5	5	4	4	60	.0117	28.6	71.4
4258	.0274	.0304	56.5	2	18	2	10	12	236	.0396	14.5	85.5
4260	.0123	.0144	28.5	11	17	7	6	16	54	.0169	54.0	46.0
4262	.0160	.0186	35.5	8	13	5	4	2	118	.0227	25.7	74.3
4263	.0127	.0151	28.5	5	4	6	5	1	106	.0189	18.1	81.9
4264	.0054	.0067	14.9	3	2	2	5	0	68	.0112	12.9	87.1
4265	.0130	.0148	26.7	5	7	7	4	4	98	.0182	23.9	76.1
4271	.0086	.0098	22.8	1	7	2	6	11	58	.0104	26.9	73.1
4272	.0154	.0188	32.2	9	15	16	7	0	90	.0223	39.8	60.2
4275	.0116	.0150	29.3	5	11	11	8	0	86	.0178	31.4	68.6
4277	.0166	.0200	39.0	4	14	14	4	0	116	.0239	28.7	71.3
4278	.0102	.0134	25.8	3	8	17	10	2	72	.0156	36.5	63.5
4279	.0110	.0134	24.5	4	10	11	9	6	68	.0155	37.5	62.5
4283	.0074	.0098	18.0	1	7	8	7	3	58	.0118	29.3	70.7
4284	.0124	.0144	30.0	11	8	9	4	4	74	.0166	37.7	62.3
4290	.0116	.0140	26.0	1	7	3	3	8	118	.0186	14.5	85.5
4295	.0131	.0161	24.2	5	8	6	8	6	112	.0202	22.3	77.7
Average	0.0126	0.0153	28.4	5.6	9	7	6	4	97	0.0187	24.5	75.5
1941	.0096	.0128	24.8	6	7	5	5	4	78	0.0160	28.0	72.0

Table 6

REFLECTANCE, COLOR, ETC., NON-STEFFEN

Sample Number	Reflectance on Total Sugar	Reflectance on *Screened Fraction	Solution of Sugar Color (-log t)10^3	Solution of Sugar Turbidity (-log t)10^3	pH	Foaming Test, Maximum	Foaming Test, Final	Nitrogen (amino) ppm.
4203	92.0	91.7	0.7	1.5	6.90	100	80	6
4205	91.8	91.4	0.7	1.8	7.26	105	80	4
4206	92.0	91.4	1.1	3.5	7.00	105	80	13
4208	91.8	91.4	1.1	2.4	6.98	100	80	8
4210	91.4	91.0	1.1	1.5	6.89	105	85	10
4211	91.6	91.2	1.1	2.2	6.95	105	90	12
4212	92.5	91.8	2.2	12.0	6.28	105	80	8
4214	93.7	91.8	2.0	2.0	6.89	100	85	8
4215	93.7	92.5	2.2	4.0	6.99	125	90	10
4216	92.4	92.2	2.7	2.7	6.87	100	85	9
4217	92.7	90.5	1.3	7.0	6.80	100	70	10
4218	91.8	91.1	2.4	4.5	6.40	100	85	9
4221	91.5	90.0	3.2	4.5	6.92	105	90	8
4222	92.8	91.8	0.4	4.5	7.01	105	85	12
4223	92.8	92.1	1.8	2.2	7.11	100	80	12
4225	92.4	91.7	0.9	1.5	7.32	105	90	14
4232	92.8	91.1	1.8	1.9	6.81	105	85	8
4234	90.9	90.5	2.9	2.2	6.81	110	80	8
4235	93.6	91.8	2.0	3.0	7.11	125	90	8
4236	91.8	91.2	2.0	4.5	7.00	100	75	14
4238	90.1	89.5	4.1	3.9	6.93	105	80	15
4239	92.1	91.8	2.8	5.1	7.15	110	85	10
4243	93.1	91.6	2.0	1.8	7.10	100	75	10
4244A	91.7	90.3	2.7	2.2	7.30	95	80	9
4244B	89.4	89.0	4.5	4.5	7.42	105	80	14
4245	91.8	90.8	3.9	2.8	7.12	105	80	10
4247	92.2	91.6	3.4	4.9	7.09	100	75	11
4249	91.9	90.4	1.1	6.8	6.75	100	70	7
4250	92.2	91.4	0.7	2.7	6.90	100	80	7
4251	90.5	89.9	5.8	5.8	6.93	100	85	16
4252	89.2	88.6	4.1	13.0	6.82	90	70	18
4254	92.8	92.3	1.5	9.3	6.90	100	80	12
4259	92.7	92.3	1.8	2.0	6.90	105	85	8
4261	91.8	90.8	1.8	9.2	6.38	105	80	4
4266A	91.2	90.8	0.7	4.5	6.70	100	75	6
4266B	91.7	90.8	1.2	6.0	6.52	95	80	10
4267	92.2	91.8	0.4	2.2	7.00	100	80	11
4269	91.8	91.3	2.6	5.0	6.90	100	75	15
4270	92.8	91.1	1.5	5.9	7.19	115	90	13
4273	92.0	90.8	2.9	3.5	7.00	100	80	11
4274	92.6	91..	2.2	6.3	6.78	100	75	12
4276	92.1	91.7	2.0	2.4	7.30	90	75	10
4280	92.4	92.0	2.4	2.8	6.78	100	95	12
4282	91.7	91.3	1.7	2.2	7.11	105	80	11
4291	87.7	87.2	1.1	4.3	7.38	100	80	18
4294	90.0	89.3	2.8	4.5	7.15	100	75	11
Average	92.0	91.2	2.06	4.20	6.91	103.1	81.4	10.3
Avg.1941	91.8	91.2	1.59	4.71	6.84	117	83	12.1

* Fraction passing 40 retained on 50.

Table C

REFLECTANCE, COLOR, ETC., STEFFEN

Sample Number	Reflectance on		Solution of Sugar			Foaming Test		Nitrogen (amino)
	Total Sugar	*Screened Fraction	Color $(-\log t)10^3$	Turbidity $(-\log t)10^3$	pH	Maximum	Final	ppm
4201	92.5	91.5	1.6	3.7	6.92	95	85	10
4202	91.3	91.5	1.5	0.7	7.10	100	75	8
4204	91.8	91.4	1.5	1.5	7.00	120	90	12
4207	91.8	91.5	1.6	2.5	7.19	95	75	11
4209	90.7	89.5	3.7	6.0	6.80	105	85	13
4219	89.3	89.4	6.8	6.0	6.25	105	90	20
4220	91.4	90.3	2.4	3.5	7.40	100	85	6
1224	93.5	92.1	0.7	3.0	6.91	100	80	13
4226	93.2	91.9	1.7	2.1	7.03	100	80	11
4227	89.5	88.6	5.4	12.0	6.76	105	80	18
4228	90.6	89.0	3.5	7.2	6.30	105	80	14
4229	92.4	90.4	2.5	5.6	6.85	110	95	13
4230	93.5	91.8	1.3	2.4	6.98	100	85	13
4231	92.4	91.1	1.5	4.5	6.81	95	80	15
4237	93.2	92.7	2.6	2.2	6.87	105	85	15
4240	92.0	91.0	1.1	10.1	6.98	100	85	9
4241	93.3	92.5	3.0	1.5	6.99	100	85	12
4242	94.0	92.3	2.7	2.0	6.98	95	80	13
4246	91.4	90.8	1.7	5.4	6.92	90	70	13
4253	92.1	91.7	1.8	5.3	6.80	95	75	12
4255	90.8	90.2	3.5	5.4	6.40	100	80	16
4256A	92.3	92.0	1.7	2.2	6.81	100	80	9
4256B	92.8	91.2	2.2	3.6	6.68	95	75	7
4257	92.5	91.6	2.6	4.0	6.55	100	75	11
4258	90.5	89.7	5.7	16.1	7.20	130	85	18
4260	92.9	92.5	0.9	3.7	6.52	95	85	10
4262	91.5	90.6	2.6	4.5	6.43	95	75	13
4263	92.3	91.8	3.0	5.9	6.81	90	70	12
4264	91.5	91.1	3.0	5.9	6.92	100	75	6
4265	93.6	91.8	2.1	4.5	6.75	100	80	9
4271	93.1	91.3	3.5	4.5	7.39	105	85	14
4272	93.8	92.5	1.7	6.0	7.00	95	80	12
4275	92.8	91.3	1.5	5.9	7.40	100	85	16
4277	91.8	91.0	2.4	6.5	7.20	100	85	11
4278	90.5	90.0	2.6	7.3	7.42	90	80	14
4279	93.6	93.2	1.2	6.6	7.21	95	75	11
4283	91.8	91.2	2.4	4.2	6.89	120	90	13
4284	91.4	91.0	2.0	7.0	6.92	140	100	13
4290	92.6	92.1	0.7	4.5	7.60	90	70	6
4295	87.8	87.2	5.9	6.0	6.86	120	95	8
Average	92.1	91.2	2.47	5.22	6.98	101.9	81	12.4
Avg.1941	91.8	89.7	1.65	4.26	6.71	114	85	13

* Fraction passing 40 retained on 50.

the relation between the non-sugar composition of white massecuite and white sugar would be linear. The composition of white massecuite reflects that of the beets except as affected by variable proportions remelt sugars and/or Steffen sucrate.

The general increase in sulphated ash is about the same as that shown by carbonate ash. Since in beet sugars the bases (metals) present are almost entirely potassium and sodium it may be assumed that the sulphated ash is essentially potassium and sodium sulphates. Calcium (lime), which is commonly present in only very small proportions, introduces an appreciable error in this assumption in a few instances. Because the sulphated ash is so predominantly potassium and sodium sulphates the determinations of sulphates (SO_3) on the sulphated ash, that are made for the estimation of ash alkalinity, also furnish a check on the accuracy of the weighing of the sulphated ashes. If the SO_3 percent on sulphated ash does not fall between the limits of the SO_3 content of potassium and sodium sulphates there is a strong probability that the analytical work is in error. This check was applied to the sulphated ashes reported.

It is also possible to approximate the K_2O-Na_2O distribution and percentages by means of the SO_3 percentages on sulphated ash. It is not felt, however, that the analytical work has sufficient accuracy for this calculation on individual samples.

Specific conductivity was again determined on solutions of 50 grams of sugar in 100 cc.total volume. The results indicate an increase in ash in the sugars although not as much of an increase as shown by the gravimetric data. As a result the ash conductivity factors given in Table No. 9 are higher than previously reported, but actually agree better with the factors of other workers. As before it should be noted that a higher factor should be used in area No. 1 (see Table no. 9) than in the other areas. This is probably due to the relatively greater proportions of organic salts in the sugars of this area.

2. Sulphites

Sulfite contents (as SO_2) remained low, in fact the values on the non-Steffen sugars averaged a third lower than last year and there was a slight decrease in the Steffen sugars. As the sulphur used was as usual it would appear that sulphite elimination in process was better than previously. Since the campaign of 1939 the sulphite content of the sugars has been reduced by half. The number of sugars with SO_2 above 10 parts per million was 28% of the total in 1939 and this year only 14% of the sugars were over this value.

3. Sulphates

The sulphate (SO_3) content of the sugars increased slightly above the 1941 level and accounts for a small part of the increase in ash. Sugars with over 10 parts per million of SO_3 amounted to 35% of the total; this compares with 27% last year.

4. Chlorides

The chloride (Cl) content of the sugars, like sulphates, increased slightly. The sugars with over 10 parts per million of Cl are produced in areas Nos. 3 and 4 (with one exception). This is distinctly probably due to a high content of Cl in the beets of these regions (see Table No. 9). Area No. 1 is especially low in chlorides.

5. Lime

The lime (CaO) content of the sugars was determined direct on solutions of the sugars instead of on the ashes. The following procedure was used. To the solution of the 100 grams of sugar in 150 cc. of water was added 25 cc. of a solution of calcium chloride containing the equivalent of 40 p.p.m. of CaO based on the sugar. (The particular strength of the calcium chloride salting solution is not important but about 0.3 gram of the salt per liter is a convenient concentration. The exact content is of course determined several times). There is then added about a quarter of a gram of solid oxalic acid, three grams of ammonium

chloride, five cc. of 10% acetic acid and half a cc. of bromcresol green indicator. After heating to boiling, dilute ammonium hydroxide was added slowly until a sea-green color was attained. Boiling was continued for three minutes and the precipitate settled for three hours on a boiling water bath. The calcium oxalate precipitate was filtered off in a well packed Gooch crucible using hot 1% ammonium oxalate for washing except for a final small washing with water. The oxalate was dissolved out with sulphuric acid (10 cc. of 5 to 1) and the solution titrated hot against hundredth normal potassium permanganate. The resulting titration value was corrected for the CaO from the added calcium chloride and then calculated to CaO on sugar. The method was checked against known additions of a lime salt to sugar solutions and also compared with determinations of lime made on sugar ashes. The results indicated satisfactory accuracy.

The CaO content of the sugars averaged about the same as last year with very few sugars exceeding 8 p.p.m. As reported previously, lime salts on white massecuite and lime content of the sugars are fairly well correlated.

6. Silica

The silica or acid insoluble portion of the ash is an especially inaccurate determination and is significant only when the values on a number of samples are averaged. The annual averages are slightly below last years'.

7. Organic Acid Radicals and Total Salts

As in the previous two reports, the combined organic acid radicals are calculated from the true ash alkalinity, arbitrarily using 80 as the combining weight of the acid. It is to be noted that the average values for the non-Steffen sugars increased by 13 p.p.m. and for the Steffen sugars by 19 p.p.m. These increases account for most of the increase in ash as the small increases in sulphates and chlorides were compensated for by the decrease in sulphites. In fact, the total inorganic salts (the sum of the calculated potassium salts of the determined sulphite, sulphate and chloride plus silica) were lower this year in the case of the

non-Steffen sugars and unchanged in the Steffen sugars. The proportion of organic salts, based on total salts, increased.

As in other years the organic salt content and the organic salt proportion of the total salts is greater in the Steffen sugars than in the non-Steffen. The higher ash of the Steffen sugars is due to the bases associated with these organic salts. There is a possibility that this high content of organic salts in Steffen sugars may be derived from either the acids formed by breakdown of glucose or from particular acids which may be precipitated with the sucrate and like raffinose built up in the molasses processed. It has been determined that the concentration of organic salts in white massecuite and molasses in Steffen factories is higher than in non-Steffen so it is natural that the sugars would also show these characteristics.

Again it can be pointed out that the higher ash of the sugars in area No. 1 (see Table No. 9) is also due to high organic salts; the inorganic salts are lower than in other areas. The amount of total salts is especially low in area No. 2 and the lowest proportion of organic salts is in area No. 3. Sugars Nos. 4259 and 4267 furnish a good example of the contrast in ash from the same total salt content where the compositions of the salts are strikingly different. The highly mineral salt composition in No. 4259 which yielded a carbonate ash of 0.0128, is contrasted with 0.0089% ash from the highly organic salt content of sugar No. 4267.

8. pH of Sugar Solutions

The pH of the sugars was measured electrometrically on solutions containing 30 grams of sugar per 100 cc. The average pH is slightly higher than in 1941. The discussion of the relation of the pH of the sugars to other factors given in the last report cannot be enlarged upon.

9. Color and Turbidity of Sugar Solutions

Color was measured by the filtration method used last year. Solutions containing 60 grams of sugar per 100 cc. were filtered using a vacuum receiver so that the first half of the filtrate could be rejected without breaking the vacuum. A precoat of standard filter-cel was made on the filter paper on a very small Buchner

funnel, and additional standard filter-cel was mixed in the sugar solution. It is admitted that perfect clarity is not obtained by this filtration, but it is felt that it reduces turbidity to a very low intensity which affects the color measurements uniformly. Using an abridged spectrophotometer and a 10 centimeter cell, color was measured on the filtered solution against water and turbidity was measured on the original sugar solution against the filtered sugar solution. The percent transmission was calculated to (-log t) values.

The colors determined averaged higher than last year following the trend of the ash values. Turbidity was increased on the Steffen sugars but were lower on the non-Steffen. The contrasts between group averages (Table No. 9) are as usual. The increases in color are uniformly greater in the Steffen groups than in the non-Steffen even as in the case of the ash.

10. Reflectance

Reflectance (B-K values), on the average, equaled or bettered the 1941 values, both on the whole sugars and on the screened fractions passing No. 40 and retained on No. 50 screens. Reflectance of the screened fraction and solution color show considerable correlation as demonstrated in the previous report.

11. Foaming Test

While the foaming tests were stirred until near the boiling point, as in the new technique described last year, the foaming test results are relatively low. The reason for this is not readily evident and time did not permit a special study. As it is, the foaming tests are much better than last year, especially on sugars from areas where usually the foaming test has been high.

12. Nitrogen

The approximate amino nitrogen content was again estimated by the copper nitrate colorimetric method. The technique used was to clarify 200 cc. of a sugar solution containing 30 grams of sugar per 100 cc., using three drops of saturated neutral lead acetate followed by filtration with standard filter-cel.

Table 7

RATING AND PURITY (calculated)

Sample Number	NON-STEFFEN Rating Percentage	Purity	Sample Number	STEFFEN Rating Percentage	Purity
4203	97.2	99.983	4201	96.7	99.976
4205	96.3	.979	4202	97.0	.978
4206	95.1	.968	4204	92.5	.961
4208	96.3	.975	4207	96.4	.976
4210	95.8	.978	4209	87.2	.960
4211	95.3	.973	4219	82.1	.946
4212	87.5	.963	4220	92.7	.980
4214	96.0	.977	4224	96.6	.967
4215	92.7	.977	4226	97.0	.970
4216	95.0	.977	4227	81.1	.957
4217	94.0	.979	4228	87.1	.958
4218	92.0	.971	4229	92.2	.971
4221	90.5	.979	4230	95.8	.964
4222	96.2	.971	4231	94.1	.964
4223	95.9	.963	4237	84.5	.962
4225	96.7	.962	4240	90.0	.966
4232	96.5	.979	4241	95.6	.969
4234	92.4	.979	4242	97.2	.966
4235	93.5	.973	4240	94.8	.973
4236	93.0	.971	4253	94.5	.975
4238	89.2	.969	4255	88.8	.961
4239	90.9	.963	4256A	95.8	.977
4243	97.2	.976	4256B	95.7	.980
4244A	95.2	.979	4257	94.5	.976
4244B	87.7	.974	4258	74.3	.941
4245	92.7	.980	4260	96.4	.972
4247	92.9	.965	4262	91.9	.963
4249	91.7	.961	4263	93.0	.966
4250	97.4	.963	4264	91.8	.962
4251	86.7	.966	4265	95.3	.972
4252	83.0	.964	4271	93.7	.974
4254	90.8	.975	4272	93.8	.965
4259	92.9	.979	4275	94.0	.965
4261	88.7	.963	4277	90.7	.964
4266A	95.2	.962	4278	90.6	.969
4266B	94.9	.978	4279	95.0	.973
4267	96.1	.976	4283	91.6	.974
4269	92.5	.971	4284	85.6	.969
4270	92.1	.966	4290	97.8	.972
4273	92.7	.972	4295	79.7	.971
4274	93.2	.972	Average	92.2	99.968
4276	97.4	.962	Avg.1941	90.4	99.972
4280	95.6	.974			
4282	94.7	.977			
4291	88.7	.959			
4294	90.5	.974			
Average	93.5	99.975			
Avg.1941	89.7	99.975			

Table 8

SCREENING TESTS, NON-STEFFEN

Sample Number	Percent Retained on Screens U.S. No. 20	30	40	50	60	70	80	100	Thru 100	On 30	Thru 30 on 50	Thru 50 on 70	Thru 70
4203	0	0.0	20.2	46.0	8.8	0.0	4.0	3.2	1.0	0.0	75.2	15.4	0.0
4205	0	0.0	17.0	44.2	11.40	9.0	7.4	6.0	3.0	0.0	61.0	21.2	10.4
4206	0	1.2	15.4	43.2	12.4	10.6	7.6	6.0	3.0	1.2	58.6	23.0	17.2
4208	0.2	0.0	17.4	40.0	10.4	9.2	8.2	7.0	6.2	1.0	57.4	19.0	22.0
4210	0	1.0	20.0	47.4	5.6	6.6	5.0	3.0	2.8	1.0	75.4	12.2	11.4
4211	0	1.2	30.2	44.0	8.2	4.2	2.6	1.2	0.4	1.2	82.2	12.4	4.2
4212	0	0.2	9.2	52.0	13.0	9.0	6.0	4.0	2.0	0.2	62.0	23.4	14.4
4214	0	0.2	11.0	51.4	12.2	9.4	7.4	5.2	2.4	0.2	63.2	21.6	15.0
4215	0	0.4	12.0	42.0	11.0	11.4	9.0	9.0	5.0	0.4	54.0	23.0	22.6
4216	0	0.0	20.4	44.2	7.6	7.4	5.4	4.2	2.2	0.0	72.0	15.0	11.0
4217	0	0.4	21.0	49.0	10.0	7.0	5.4	3.0	2.0	0.4	70.0	17.0	11.2
4218	0	1.4	20.0	35.0	10.2	9.0	7.0	6.4	3.4	1.4	62.0	19.2	16.0
4221	0	0.2	17.6	54.4	11.2	6.0	4.0	3.2	2.2	0.2	72.0	17.0	10.0
4222	0	1.0	25.0	38.0	8.0	8.0	6.0	6.0	6.0	1.0	63.0	10.0	19.2
4223	0.2	0.0	11.0	46.0	12.0	11.0	7.0	6.0	3.2	0.0	57.0	24.0	17.0
4225	0	0.4	21.0	46.2	10.0	7.6	6.0	4.0	2.0	0.4	68.0	18.2	13.4
4232	0	0.2	21.0	49.0	10.4	7.0	5.0	4.0	3.4	0.2	70.0	17.4	12.4
4234	0	0.0	30.4	39.0	8.4	7.4	6.0	5.0	3.2	0.0	69.2	15.0	14.2
4235	0	0.2	19.0	51.0	8.0	8.4	6.4	4.0	2.4	0.2	70.0	10.4	13.4
4236	0.2	4.4	30.0	36.0	9.0	5.0	3.0	2.2	0.0	4.6	73.4	15.4	6.0
4238	0	1.0	30.0	44.4	7.6	4.6	2.0	1.2	0.4	1.0	82.4	12.2	4.4
4239	0	0.4	14.0	47.2	9.2	11.0	8.4	6.0	4.4	0.4	62.0	20.2	17.4
4243	0	0.0	16.0	42.0	11.0	11.2	8.0	6.4	4.0	0.0	58.2	22.0	17.8
4244A	0	1.2	18.4	48.4	12.0	7.4	5.4	4.4	2.0	1.2	66.8	19.4	12.6
4244B	0	0.4	20.0	44.6	9.2	8.0	5.6	4.0	2.0	0.4	70.6	18.0	13.0
4245	0	0.4	32.8	41.2	7.6	7.2	5.2	4.2	1.4	0.4	73.0	15.0	10.0
4247	0	0.2	9.0	45.0	12.2	12.0	8.0	8.0	5.4	0.2	54.0	25.0	20.2
4249	0	0.2	19.2	49.2	9.0	8.6	6.0	4.0	3.0	0.2	68.4	17.6	13.8
4250	0.2	0.4	23.0	46.0	9.6	7.2	6.0	4.4	2.4	0.6	69.0	16.0	12.8
4251	0.2	1.6	36.0	41.4	8.4	5.6	3.0	2.2	0.0	1.8	77.4	14.0	6.8
4252	0	2.0	33.4	36.0	9.0	8.8	5.0	4.2	3.0	2.0	70.2	15.6	12.2
4254	0	0.2	11.4	44.0	9.6	10.6	9.2	8.0	7.0	0.2	55.4	20.2	24.2
4259	0	1.6	36.2	36.6	8.4	6.4	5.2	3.0	1.0	1.0	72.8	14.0	10.0
4261	0	0.2	6.4	55.0	11.6	11.0	7.2	5.6	3.0	0.2	61.4	22.6	15.0
4266A	0.2	7.6	30.2	33.2	9.4	6.2	5.4	4.4	3.4	7.8	63.4	15.6	13.2
4266B	0	0.4	22.0	45.6	9.6	6.0	6.4	5.0	4.2	0.4	67.6	16.4	15.6
4267	0	1.2	34.4	44.2	8.0	6.0	3.4	1.0	0.4	1.2	78.6	14.6	5.0
4269	0	0.4	21.0	43.0	10.2	8.20	6.2	5.2	4.2	0.4	65.0	18.4	15.6
4270	0	0.6	18.6	45.0	11.4	9.6	7.4	6.0	3.4	0.6	61.6	21.0	16.8
4273	0	2.0	22.2	36.6	12.2	9.6	7.0	6.2	3.4	2.0	58.8	21.8	17.4
4274	0	0.4	12.2	43.0	10.8	11.0	8.0	8.4	5.6	0.4	55.2	21.8	22.6
4276	0	0.4	23.6	50.6	9.8	6.6	4.8	2.8	1.4	0.4	74.2	18.4	9.0
4280	0	0.7	20.5	47.8	11.3	7.7	5.5	4.0	2.5	0.7	68.3	19.0	12.0
4282	0	0.2	22.8	45.6	9.2	7.2	5.6	5.2	4.2	0.2	68.4	18.4	15.0
4291	2.6	40.6	43.0	11.0	1.6	0.6	0.2	0.2	0.2	43.2	54.0	2.2	0.6
4294	0.2	4.8	30.0	36.0	9.0	5.0	3.2	2.0	0.4	5.0	75.4	14.0	5.6
Average	0	0.8	22.3	44.7	9.7	8.3	6.2	4.9	3.1	0.8	67.0	18.0	14.2
Avg.1941	0.1	0.7	23.4	42.7	10.3	8.3	6.4	4.9	3.2	0.8	66.1	18.0	14.5

Table 8

SCREENING TESTS, STEFFEN

Sample Number	Percent Retained on Screens U.S. No- 20	30	40	50	60---70	80	100	Thru 100	On 30	Thru 30 on 50	Thru 50 on 70	Thru 70
4201	0	3.2	35.6	36.4	9.6	5.6	4.0	2.6	2.4	3.2	72.2	15.4	9.2
4202	0	1.0	31.0	38.6	10.8	7.4	5.6	3.8	1.8	1.0	69.6	18.2	11.2
4204	0	3.0	40.2	28.6	7.0	7.8	6.0	4.8	2.6	3.0	68.8	14.8	13.4
4207	0	1.0	28.2	44.4	11.0	5.8	5.0	3.2	1.4	1.0	72.6	16.8	9.6
4209	0	1.2	26.6	45.2	11.8	6.4	5.2	3.0	0.6	1.2	71.8	18.2	8.8
4219	0.2	1.0	43.6	38.4	6.4	4.8	3.4	1.8	0.4	1.2	82.0	11.2	5.6
4220	0	0.4	28.4	39.2	9.2	6.6	6.0	6.0	4.2	0.4	67.6	15.8	16.2
4224	0.2	0.4	11.8	45.2	14.8	9.8	8.0	5.4	4.4	0.6	57.0	24.6	17.8
4226	0	0.2	22.0	56.0	10.4	5.4	3.4	2.0	0.6	0.2	78.0	15.8	6.0
4227	0	0.6	22.0	45.6	11.2	7.2	5.6	4.2	3.6	0.6	67.6	18.4	13.4
4228	0	2.2	28.6	44.6	10.8	6.2	4.8	2.4	0.4	2.2	73.2	17.0	7.6
4229	0	1.2	29.4	45.2	8.8	6.2	4.6	3.0	1.6	1.2	74.6	15.0	9.2
4230	0	2.2	27.6	42.0	9.6	6.8	6.0	4.0	1.8	2.2	69.6	16.4	11.8
4231	0	0.2	11.2	51.4	12.0	8.4	6.6	5.0	3.2	0.2	62.6	22.4	14.8
4237	0	0.4	14.0	46.4	10.2	9.2	7.8	7.0	5.0	0.4	60.4	19.4	19.8
4240	0	0.2	11.8	49.6	11.8	9.0	7.2	6.2	4.2	0.2	61.4	20.8	17.6
4241	0	0.2	12.4	52.4	13.2	8.2	6.2	4.4	3.0	0.2	64.8	21.4	13.6
4242	0	0.2	9.2	43.6	12.2	9.6	9.4	8.8	7.0	0.2	52.8	21.8	25.2
4246	0	0.6	20.8	44.8	10.6	8.4	6.8	5.2	2.8	0.6	65.6	19.0	14.8
4253	0	0.2	7.8	55.0	10.8	9.4	6.8	5.8	4.2	0.2	62.8	20.2	16.8
4255	0.2	1.8	31.8	42.8	9.0	6.0	4.2	3.0	1.2	2.0	74.6	15.0	8.4
4256A	0	0.2	14.8	54.6	11.4	7.0	5.2	4.0	2.8	0.2	69.4	18.4	12.0
4256B	0	2.6	48.4	32.8	6.8	3.6	2.8	1.8	1.2	2.6	81.2	10.4	5.8
4257	0	0.2	13.0	53.8	10.8	9.6	6.2	4.4	2.0	0.2	66.8	20.4	12.6
4258	0.8	7.6	42.0	30.8	7.2	5.2	4.0	2.0	0.4	8.4	72.8	12.4	6.4
4260	0	0.6	18.0	36.0	12.2	10.6	10.0	8.0	4.6	0.6	54.0	22.8	22.6
4262	0	1.8	28.2	44.8	10.4	6.8	4.4	2.6	1.0	1.8	73.0	17.2	8.0
4263	0	1.2	26.2	44.6	9.8	7.2	5.6	3.6	1.8	1.2	70.8	17.0	11.0
4264	0	0.2	26.6	47.8	9.0	7.0	4.6	3.6	1.2	0.2	74.4	16.0	9.4
4265	0	0.6	21.6	42.6	9.4	7.0	6.2	6.2	6.4	0.6	64.2	16.4	18.8
4271	0	0.2	18.0	48.0	10.4	7.8	5.8	5.2	4.6	0.2	66.0	18.2	15.6
4272	0	0.2	7.8	45.8	15.6	9.2	7.8	7.2	6.4	0.2	53.6	24.8	21.4
4275	0	0.4	37.2	42.6	9.4	5.2	3.4	1.4	0.4	0.4	79.8	14.6	5.2
4277	0	0.4	29.2	52.4	8.0	4.8	3.2	1.4	0.6	0.4	81.6	12.8	5.2
4278	0	2.0	36.2	37.4	8.0	6.4	5.0	3.6	1.4	2.0	73.6	14.4	10.0
4279	0	0.2	4.0	43.8	15.6	11.4	8.6	7.8	8.6	0.2	47.8	27.0	25.0
4283	0	0.2	27.0	48.2	8.6	6.0	4.4	3.6	2.0	0.2	75.2	14.6	10.0
4284	0	0.2	11.4	55.0	10.2	7.6	6.2	5.0	4.4	0.2	66.4	17.8	15.6
4290	0.2	2.8	18.2	40.4	15.0	8.4	6.6	4.2	4.2	3.0	58.6	23.4	15.0
4295	0.2	4.8	36.2	32.6	9.6	6.0	5.0	3.8	1.8	5.0	68.8	15.6	10.6
Average	0	1.1	23.6	44.7	10.5	7.3	5.7	4.3	2.8	1.1	68.3	17.8	12.8
Avg.1941	0	0.7	22.7	44.7	11.3	7.5	5.8	4.5	2.8	0.7	67.4	18.8	13.1

Ten cc. of the copper reagent was pipetted into a 100 cc graduated flask which was then filled to the mark with the filtered sugar solution, mixed and desecrated. (Copper reagent consists of 10 grams of pure crystalline copper nitrate and 250 grams of crystalline sodium acetate per liter. The solution is filtered after standing a couple days.) The color was read with a photoelectric abridged spectrophotometer and compared with a standard curve prepared using glutamic acid and the same procedures.

The average results are slightly below last year but show the same trends in the group averages (Table No. 9). The nitrogen values were calculated to glutamic acid and combined with the estimated total salts to arrive at the calculated sugar purities given in Table No. 7.

When using the neutral lead clarification it was noted that some sugar solutions gave high turbidity and others remained unchanged. Rough observations of the intensity of the turbidities seem to correlate with the sulphite content of the sugars. Sugars with less than 5 p.p.m. of SO_2 gave no turbidity. With higher concentrations of SO_2, turbidity rapidly increased. There was not any correlation of the turbidity with organic salt, sulphate, or nitrogen content.

13. Formula Ratings and Sugar Purity

As in the previous report the formula ratings were calculated to a percentage rating based on an arbitrarily adopted standard sugar analysis. In spite of the higher color and ash the improved foaming test brought about an apparent improvement in the percentage ratings. The calculated sugar purities (on dry basis) averaged the same as in 1941 in the case of the non-Steffen sugars but dropped slightly on the Steffen sugars.

The correlations of white pan purities with the percentage ratings and sugar purities confirm the observations made last year.

14. Screening Tests

The average screening analysis agrees closely to that of the 1941 sugars.

The trend toward finer grain sugars has become stabilized.

15. Regional Averages

Numerous references have already been made to the regional averages given in Table No. 9 and further comment is unnecessary.

16. Summary

In spite of the operating difficulties due to inexperienced labor, lower sucrose in beets and lower juice purities, the sugars produced in 1942 have been found of excellent chemical and physical quality. Such changes as did occur are believed to be due to seasonal effects on the composition of the non-sugars of the beets.

Table 9

REGIONAL AVERAGES, NON-STEFFEN

AREA---	1.		2.		3.		4.	
	1941	1942	1941	1942	1941	1942	1941	1942
Sucrose of beets ----------	14.8	14.7	17.0	16.7	15.8	14.9	16.8	16.7
Purity Diffusion Juice------	86.0	85.9	87.3	86.6	87.1	86.9	88.7	88.3
Lime used (% beets)---------	2.45	2.47	2.44	2.41	1.56	1.58	2.23	2.05
Soda Ash used (% beets)------	0.10	0.07	0.19	0.33	0.09	0.14	0.00	0.03
Lime Salts, Std. Liq.-------	0.051	0.046	0.036	0.048	0.024	0.029	0.027	0.030
Sulphur used(lbs.per ton)---	0.36	0.41	0.25	0.30	0.52	0.50	0.45	0.49
pH Thin Juice---------------	8.6	8.6	8.5	8.5	8.1	8.1	7.9	7.8
pH Thick Juice--------------	8.6	8.9	8.8	8.7	8.7	8.9	8.4	8.6
pH White Masscouite---------	8.0	8.5	8.8	8.5	8.6	8.9	8.3	8.5
pH White Sugar--------------	6.9	6.9	6.7	6.9	6.8	7.0	6.8	6.9
Purity,White Massecuite-----	91.6	92.2	94.0	93.9	91.9	91.9	92.3	92.3
Purity,White Sugar(calc'd)--	99.968	99.972	99.979	99.978	99.970	99.976	99.976	99.974
Carbonate Ash,p.p.m.--------	100	100	60	77	70	95	92	117
Sulphated Ash,p.p.m.--------	131	125	84	94	101	113	119	138
Total Salts(calc'd)p.p.m.---	160	151	103	115	115	133	133	156
Organic Salts, % total------	74.4	73.1	69.4	73.2	46.9	63.8	50.4	62.2
Inorganic Salts, % total----	25.6	26.9	30.6	26.8	53.1	36.2	49.6	37.8
Specific Conductivity X10^6--	24.9	22.0	16.2	17.3	21.4	22.2	24.2	25.8
Carb.Ash Cond.Factor X10^6---	402	454	370	445	327	428	380	453
Sulp.Ash " " " ---	526	568	519	543	472	509	492	535
Tot.Salts " " " ---	643	686	636	665	537	599	550	605
Sulphites(SO_2)in sug.p.p.m.-	7	5	4	3	9	5	14	9
Sulphates(SO_3) " " " -	7	8	6	5	10	10	8	11
Chlorides(Cl) " " " -	3	4	4	5	7	6	5	8
Silica (SiO_2) " " " -	11	5	3	4	6	5	4	4
Lime (CaO) " " " -	6	5	6	6	3	3	4	4
Org.Acid(Combined)" " -	84	76	48	60	36	60	45	65
Reflectance,B-K value-------	91.1	91.5	92.2	91.9	92.0	92.1	92.3	92.4
" Screened fraction---	90.2	90.7	91.3	91.0	91.4	91.3	92.0	91.5
Color in solution(-log t)---	2.4	3.0	1.3	1.8	1.3	1.6	1.2	1.7
Turbidity " (-log t)X10^6--	6.6	5.2	4.2	3.9	3.4	2.6	4.8	5.4
Foaming Test Maximum--------	121	102	108	101	122	104	109	103
Nitrogen (amino) p.p.m.-----	16	12	11	10	11	10	11	9
Percentage Rating----------	88.0	91.3	94.8	94.8	92.4	95.3	92.8	93.1

Table 9

REGIONAL AVERAGES, STEFFEN --

AREA---	1.		2.		3.		4.	
	1941	1942	1941	1942	1941	1942	1941	1942
Sucrose of Beets----------	14.8	14.4	16.8	16.8	15.2	14.6	16.6	16.7
Purity Diffusion Juice-----	85.5	85.1	85.3	85.6	86.3	85.8	88.5	86.9
Molasses worked,% beets----	6.1	5.6	7.8	6.9	5.4	5.7	5.4	4.9
Lime used (% beets)--------	4.4	4.2	4.1	4.3	3.0	3.4	3.4	3.3
" ",% per 1% molasses--	0.72	0.75	0.57	0.62	0.59	0.60	0.64	0.67
Soda Ash used, lbs.per ton-	0.73	0.63	1.21	1.23	0.30	0.27	0.25	0.07
Lime Salts, Std. Liquor----	0.067	0.086	0.062	0.091	0.045	0.047	0.046	0.041
Sulphur used,lbs.per ton---	0.29	0.34	0.33	0.32	0.46	0.44	0.33	0.33
pH Thin Juice-------------	8.6	8.5	8.7	8.7	8.2	8.2	8.2	8.3
pH Thick Juice------------	8.5	8.7	8.2	8.1	8.5	8.6	8.1	8.5
pH White Massecuite--------	8.0	8.4	7.8	8.0	8.3	8.4	8.0	8.3
pH White Sugar------------	6.8	6.7	6.7	7.0	6.7	6.9	6.6	6.9
Purity White Massecuite----	91.9	91.3	94.1	93.3	92.0	91.8	92.6	92.8
Purity White Sugar(calc'd)-	99.967	99.960	99.979	99.976	99.973	99.968	99.974	99.971
Carbonate Ash, p.p.m.------	108	156	62	79	103	130	96	117
Sulphated Ash, p.p.m.------	144	184	82	101	134	158	127	141
Total Salts (calc'd) ------	190	237	108	124	162	188	160	167
Organic Salts, % total-----	83.7	83.3	75.9	73.3	64.2	68.2	72.5	69.9
Inorganic Salts, % total---	16.3	16.7	24.1	26.7	35.8	31.8	27.5	30.1
Specific Conductivity $X10^5$-	27.0	33.6	15.8	18.4	27.5	29.6	23.6	26.7
Carb.Ash Cond.Factor $X10^6$--	400	464	392	429	375	439	407	438
Sulp.Ash " " " --	533	548	519	549	487	534	538	528
Tot.Salts " " " --	704	705	684	674	589	635	678	625
Sulphites(SO_2)in sug.p.p.m.-	4	4	3	2	9	7	8	7
Sulphates(SO_3) " " " -	6	8	5	6	10	10	6	9
Chlorides (Cl) " " " -	2	4	4	7	7	9	6	8
Org.Acid(combined)" " -	107	140	55	64	70	90	78	82
Silica (SiO_2) " " " -	5	6	4	3	4	4	4	3
Lime (CaO) " " " -	7	7	4	7	4	5	7	6
Reflectance,B-K value------	91.1	91.1	91.7	91.9	92.0	92.7	92.4	92.5
" Screened fraction---	90.4	90.3	91.0	91.1	91.3	91.6	91.8	91.6
Color in Sol'n(-log t)10^3--	2.7	3.5	1.7	2.6	1.1	1.9	1.2	1.9
Turbidity " " " " --	4.6	6.7	3.1	4.4	3.5	4.2	7.1	6.0
Foaming Test Maximum-------	107	103	116	102	120	101	107	103
Foaming Test Minimum-------	83	78	86	80	85	82	84	83
Nitrogen (amino) p.p.m.----	16	15	12	11	12	12	11	11
Percentage Rating----------	90.8	88.6	93.5	93.4	92.5	94.2	92.5	92.8

Part II

REPORT ON BIOLOGICAL STUDIES OF SUGAR

H.H. Hall and Caroline C. Clark

This year, as during the past years, the biological quality of the samples was determined by an examination for substances which stimulate the multiplication of yeast cells in sugar solutions and for the number of certain thermophilic and mesophilic microorganisms. The results, which follow, were obtained by the examination of the same factory composite samples as were used for the chemical analysis previously reported.

A new line of work has been started on the samples which pertains to the growth of molds in pharmaceutical products containing high concentrations of sugar but which do not contain preservatives. It is apparent that under some conditions of sugar manufacture minute quantities of impurities remain in the sugar which act as a nutritive substance just the same as has been encountered with yeast. This problem was only recently called to our attention and sufficient work has not been done on which to base a report. It is evident, however, that some samples of sugar contain more of the substance than others as indicated by the extent and characteristics of the growth which occurs in inoculated solutions. So far as we are aware the problem has its greatest significance with those manufacturers who are attempting to furnish sugar to pharmaceutical manufacturers and not to the food industry.

EXAMINATION FOR YEAST-STIMULATING SUBSTANCES

During the past year considerable progress was made toward the identification of the substances in sugar which stimulate the multiplication of yeast in sugar solutions. In previous reports your attention has been called to the presence of minute quantities of substances in sugar which are analogous to vitamins, in that, by their presence, yeast cells are able to utilize non-sugar impurities and multiply in sugar solutions. Biotin, a member of the vitamin B complex, was

recently identified in alcoholic extracts of beet and cane sugar and is present in quantities ranging from 0.025 to 0.445 microgammas per gram of dry sugar.

The method which has been used during the course of this study for determining the yeast inoculum multiples in sugar is inadequate for the quantitative estimation of the biotin content of the sugar but is considered adequate to determine whether or not a sugar is sufficiently free of stimulative substances to make its use in beverage manufacture satisfactory. For determination of the yeast inoculum multiple 100 ml. of sterile sugar solution is inoculated with approximately 50,000 yeast cells per ml. and incubated at 30° C. for 72 hours. After incubation the number of cells is determined in terms of the multiple of the number inoculated into the solution. The values obtained for the yeast inoculum multiple are given in Table I and the samples are ranked in ascending order of the multiple values.

The average yeast inoculum multiple for all samples this year is 4.2 which is in contrast to 6.6 for the campaign year 1941 and 8.0 for the campaign year 1940. The average ash content is 0.014 percent for the samples having multiples below 4.2 and 0.0119 percent for those having multiples of 4.2 and above. This correlation with the ash content of the samples has existed during previous years. It has been pointed out previously that this is not an exact correlation because some of the high ash content samples have low multiple values. The reason for this lack of correlation is probably due to the presence of the stimulant in such small quantities as to be significantly associated with other non-sugar impurities. The largest yeast inoculum multiple is 18.8 and is well within the limit for satisfactory sugar for beverage purposes.

For the benefit of those who have not had access to this report during the past years and as a review of the progress that has been made on the study of yeast growth-promoting substances in sugar, a brief review of the entire subject seems advisable at this time.

TABLE I

Ranking of Sugar Samples Collected During 1942 Campaign

Sample	Rank	Yeast Inoculum Multiple	Sample	Rank	Yeast Inoculum Multiple
4203	1	1.0	4264	45	3.3
4212	2	1.0	4291	46	3.5
4220	3	1.0	4237	47	3.7
4222	4	1.0	4266B	48	3.7
4246	5	1.0	4273	49	3.7
4253	6	1.0	4204	50	3.9
4259	7	1.0	4206	51	3.9
4265	8	1.0	4262	52	3.9
4272	9	1.0	4276	53	3.9
4274	10	1.0	4213	54	4.3
4282	11	1.0	4243	55	4.3
4290	12	1.0	4278	56	4.7
4255	13	1.2	4205	57	4.9
4256B	14	1.4	4228	58	4.9
4275	15	1.4	4284	59	4.9
4244A	16	1.5	4218	60	5.0
4257	17	1.5	4239	61	5.1
4208	18	1.7	4283	62	5.1
4211	19	1.7	4209	63	5.3
4229	20	1.7	4279	64	5.3
4254	21	1.9	4217	65	5.4
4260	22	1.9	4261	66	5.4
4271	23	1.9	4280	67	5.7
4294	24	1.9	4226	68	6.0
4201	25	2.1	4250	69	6.1
4210	26	2.1	4234	70	6.2
4225	27	2.1	4235	71	6.3
4230	28	2.1	4244B	72	6.3
4249	29	2.1	4252	73	6.6
4263	30	2.3	4269	74	6.8
4238	31	2.4	4270	75	6.8
4214	32	2.5	4231	76	7.0
4216	33	2.7	4236	77	7.0
4277	34	2.7	4240	78	7.0
4224	35	2.9	4241	79	7.4
4232	36	2.9	4202	80	7.8
4267	37	2.9	4258	81	7.8
4295	38	2.9	4266A	82	9.6
4207	39	3.1	4219	83	12.5
4215	40	3.1	4245	84	12.7
4221	41	3.1	4251	85	13.7
4242	42	3.3	4223	86	16.6
4247	43	3.3	4227	87	18.8
4256A	44	3.3			

In about 1929 it was observed that when sterile solutions, which were made from different beet and cane sugars, were inoculated with yeast cells, which had been obtained from a bottle of spoiled beverage, the extent of growth of the cells was variable. Some sugars were observed to support the growth of large crops of yeast while others were able to support little or no growth. This observation lead to the belief that a substance or substances was present in sugar which was utilized by the yeast cell in its metabolism and that multiplication was dependent upon the presence of the substance, which, for the lack of a more descriptive term was called, "yeast growth-promoting substance."

Experimentation indicated that when the substance was present in sugar the maximum amount of multiplication was obtained in 10 percent solutions. On the basis of these observations, a standard technique was developed for the evaluation of the quality of the sugar in which the ability of the sugar to support yeast growth was measured in numerical terms. A detailed description of the technique is as follows: 10 grams of each sample to be tested are weighed into a 300 ml. Erlenmeyer flask fitted with a cotton plug. Sufficient distilled water is added to give 100 ml. of a 10 percent solution after sterilization in the autoclave at 15 pounds pressure for 20 minutes. Following sterilization and cooling, the solutions are inoculated with the yeast culture. For the purpose of this report, the inoculating suspension is designated as the "inoculum" and is the number of cells introduced per ml. of test solution. The inoculum is prepared from a 24-hour culture grown on a wort agar slant. The mass of cells is transferred with a sterile transfer needle to about 100 ml. of sterile, distilled water. After vigorous shaking, the number of cells per ml. is determined by counting with a haemacytometer. The amount of inoculum necessary to add about 50,000 cells per ml. of test solution is calculated. For extreme accuracy in counting the cells and pipetting the inoculum, it should be adjusted so that from 0.5 to 1.5 ml. are used. The inoculated solutions are incubated at 30° C.

for 72 hours during which time they are gently agitated at 24-hour intervals. The number of cells that develop are determined again by counting 400 duplicate fields with a haemacytometer. A few glass beads are added to the flask to assist in breaking up clusters of cells. The number of cells that develop per ml. divided by the number of cells per ml. added by the inoculum gives a value which is designated as, the "yeast inoculum multiple." The values thus obtained from test solutions compared with the value one (1.0), the value assigned to the inoculum, is expressed as a measure of the relative amount of yeast growth-promoting substance that is present in the test sample.

By using this technique it was shownthat the yeast inoculum multiples of a group of beet and cane samples ranged from 1.0 to 58.5. These results indicated that there was no growth-promoting substance present or available to the inoculum in the first solutions, but that varying amounts were present in the remaining samples. There was no selective grouping based either on the type or the geographic area in which it was produced.

The failure of the inoculum to develop in some solutions suggested the possibility of the presence of toxic substances in the sugar, rather than a lack of growth-promoting substances. This possibility was investigated by mixing together a number of samples which supported multiplication with samples which did not, and then determining the extent of multiplication. The results obtained failed to support the idea of the possibility of the existence of toxic substances. Other tests, in which reagent sucrose (C.P. grade) was used, failed to give any indication of the presence of toxic substances in the sugar. Yeast cells, which were incubated for several days in solutions that failed to support their multiplication, were not stained by methylene blue, thus indicating that death of the cells had not occurred.

Since the stimulative substance was known to be an organic chemical compound, not contained in the ash of sugar, many attempts were made to correlate

the yeast inoculum multiple values with the non-sugar impurities as given in Part I of this report. An exact correlation has never been found to exist with any of the determined impurities. Each year there has existed, however, a relationship between the average ash content of grouped samples and the multiple values. The average ash content of the samples is lowest for those samples with multiples below the average and likewise highest for those samples with multiples above the average. This is not an exact correlation because some individual samples with high ash values have low multiple values. There is little reason to suspect that this relationship should be exact since the ash of sugar does not stimulate multiplication of yeast cells. The reason for the failure to obtain an exact correlation with other non-sugar impurities is probably because the stimulative substance is present in too small amounts as to be quantitatively associated with them.

When it was observed that some sugars did not support the multiplication of yeast cells in 10 percent solutions, while other stimulated extensive multiplication, attention was directed to a study of the nature and properties of the stimulant. A number of sugars, some of which promoted yeast growth, and some not, were extracted with alcohol by dissolving in hot, distilled water until saturated solutions resulted. After the solutions had cooled, the saturated sirups were removed, and to them 95 percent ethyl alcohol was added to result in an alcoholic concentration of 80 percent. The sugar crystallized out from these solutions and was usually complete within 96 hours. The alcoholic liquor was then removed from the crystallized sugar by decantation. After the sugar was dried, the growth-promoting abilities of the alcohol-purified sugars were then compared with those of the unpurified sugars in 10 percent solutions. The results given in Table III show the influence of alcohol purification in reducing the amount of stimulants.

Table III. Purification of Sugar by Crystallization from 80-Per cent Alcohol.

Sample	Yeast Inoculum Unpurified Sugar	Multiple Purified Sugar	Sample	Yeast Inoculum Unpurified Sugar	Multiple Purified Sugar
A	1.0	1.0	G	27.0	9.5
B	1.0	1.0	H	31.0	10.0
C	3.0	1.0	I	34.5	1.3
D	11.3	6.6	J	44.0	3.0
E	22.6	3.0	K	59.0	12.0
F	24.0	9.6	L	87.8	1.0

A substantial reduction was obtained in the amount of stimulants in all samples which originally stimulated the growth of yeast. The alcoholic extract from these sugars was purified and the stimulant was fractionated into two parts according to the method of Lucas, G. H. W. (The Fractionation of Bios and Comparison of Bios With Vitamins B and C. J. Phys. Chem. 28: 1180, (1924)), who purified and fractionated a growth-promoting substance from tea leaves. The addition of the purified fractions to solutions made from the alcohol-purified sugars supported growth to approximately the same extent as the unpurified sugars. Because of this and other observations which had been made on the characteristics of the stimulant, it was termed "bios," a name given by Wildiers, E., in 1901, (Une Noulelle Substance Indispensible au Development de la Levuro. La Cellule. 18: 313, (1901)), to an unknown substance which he found indispensible to the multiplication of yeast in mineral salt-sucrose solutions. The identity of bios and other growth-promoting substances long remained a mystery and many workers engaged themselves in their identification. Excellent reviews of the literature have been made and published by the following:

Tanner, F. W. 1925. The Bios Question. Chem. Rev. 1: 397.

Miller, W. L. 1930. "Bios." J. Chem. Educ. 7: 257.

Peskett, G. L. 1933. Growth Factors of Lower Organisms. Biol. Rev. 8:1.

Williams, R.J. 1941. Growth-Promoting Nutrilites and Their Relationship to Vitamin B and Wildiers' Bios. J. Am. Chem. Soc. 53: 783.

In 1936 the location of the stimulative substance with respect to the crystal surfaces, was determined. This knowledge was obtained by selecting 12 samples of sugar with a range of yeast inoculum multiple values of 1.4 to 12.6 and mingling the crystals with sugar solutions of densities below saturation. In this manner a portion of each crystal was dissolved away, the extent of dissolution being determined by the initial density of the solvent solution. The mingled crystals were removed from the sirup, washed with a small amount of distilled water and dried. The yeast inoculum multiple values were then determined and compared with those from the same samples before mingling. The results of this treatment are given in Table IV.

Table IV. Examination of Sugars Mingled in Sugar Sirup for Removal of Growth-Promoting Substances from Crystal Surfaces

Sample	Yeast Inoculum Multiple		Percent Reduction
	Non-Treated	Treated	
1	12.6	2.0	84.1
2	12.4	2.4	80.6
3	10.0	1.0	82.0
4	6.4	1.6	75.0
5	6.0	2.2	63.3
6	5.6	2.2	60.7
7	3.6	1.0	72.2
8	3.4	1.0	75.8
9	2.2	1.0	54.5
10	2.0	1.0	50.0
11	1.8	1.2	33.3
12	1.4	1.0	28.5

Substantial reductions were obtained in all the treated samples. The reduction was 50.0 percent or greater for 10 of the 12 samples examined, and in general, the greater the amount of stimulant present, the greater was their reduction. The smallest reduction obtained for any one sample was 28.5 percent, and the highest was 84.1 percent. Since an average of 8.4 percent of the crystal was removed by the treatment, the results indicate that the largest portions of the yeast growth-promoting substances are located at or near the crystal surface. Complete elimination of the film of mother sirup surrounding each crystal and probably a small amount of the crystal surface is suggested as a means of improving the quality of sugar.

In a study of the location of non-sugar impurities in sugar crystals, Paine and Balch (Nature and Distribution of the Non-Sugar Substances Which Affect the Grade of Commercial Sugar. Facts About Sugar. 21: 566,(1926))found that the collodial matter present is fairly uniformly distributed throughout the crystal. While the ash is distributed throughout the crystal, the greater part of it is located in the outer half, probably in the dried film of mother liquor adhering to the surfaces of the crystal and in occlusions of the mother liquor in multiple crystals by washing in the centrifugals, since the multiple crystals are not disintegrated into single crystals until the sugar passes through the granulators where the film is then dried on the crystals. Keane, Ambler, and Byal (Impurities in White Sugars. VII. The Distribution of Impurities in the Sugar Crystal. Ind. Eng. Chem. 27: 30,(1935)) showed the distribution of several impurities in sugar crystals by mingling crystals of uniform size with sugar solutions in which from 4.3 to 30.0 percent of the crystals were dissolved away. They state that analysis of the original and resulting sugars show that, in general, over 50 percent of the ash, sulfates, chlorides, sodium, potassium, and total nitrogen is located in the outer 5.0 percent of the crystal, i.e., in the surface layer; whereas color, calcium and sulfites are more uniformly distributed throughout the crystal. The

difficulties attending the elimination of the mother liquor and of washing small-grain sugar with a minimum amount of water in the centrifugals is pointed out as opposed to that of coarser grain sugar. From these observations it is apparent that in order to manufacture a "beverage" grade sugar, the film of mother liquor surrounding each crystal and possibly a small part of each crystal itself must be eliminated. Also, that less difficulty would be experienced in eliminating these portions from larger crystals of uniform size than from smaller crystals.

In order to determine if greater elimination of non-sugar substances could be obtained from crystal surfaces during centrifugation by increased quantities of centrifugal wash water, the quantity of water was changed in successive baskets of massecuite while spinning a strike of white sugar. One machine was selected in each of four factories, and for four successive baskets the quantity of water normally used was increased or decreased by two quarts. A sample of finished sugar was collected from the machine after each change while the sugar was being plowed out so that the sample was representative of the entire basket. The yeast inoculum multiple was determined for each sample of sugar. The results, together with the quantity and temperature of water used, are given in Table V.

There was a decrease in the yeast inoculum multiple values for each sample (except on sample from Factory C) when the normal quantity of wash water was increased by two quarts per machine for successive baskets of sugar. Conversely, when the normal quantity of water was decreased by two quarts per basket, the yeast inoculum multiple values (except one change) increased. These results again show that the yeast growth-promoting substance is located at or near the surface of the crystal and that increased quantities of it can be eliminated by increased quantities of wash water.

Table V. Influence on Amount of Growth-Promoting Substances of Quantity of Centrifugal Wash Water

Factory A		Factory B	
Quarts Water at 88° C.	Yeast Inoculum Multiple	Quarts Water at 72° C.	Yeast Inoculum Multiple
14*	22.7	16*	13.4
16	20.5	18	9.6
18	19.4	20	7.4
20	14.8	22	3.6

Factory C		Factory D	
Quarts Water at 86° C.	Yeast Inoculum Multiple	Quarts Water at 86° C.	Yeast Inoculum Multiple
15*	8.8	24*	3.8
17	8.8	22	3.4
19	6.4	20	6.0
21	4.8	18	7.8

* Quarts normally used.

BACTERIOLOGICAL EXAMINATION

The samples were examined again this year for the presence and numbers of organisms such as would influence the use of the sugar in certain food products. The usual examination was made for thermophilic bacteria in order to determine their suitability for canning purposes. Also, examination was made for such mesophilic organisms as would influence the quality of dairy products, frozen foods and desserts, beverages, etc.

The methods that were used are described in the Official and Tentative Methods of the Association of Official Agricultural Chemists, Fifth Edition, 1941, pp. 642-3. Although the bacterial standards that have been adopted for canning grade sugar were given in the report issued last year, they are again called to your attention. They are based on the types and numbers of the thermophilic bacterial spores and for the purposes of this report they are as follows:

Total Aerobic Thermophilic Spores, shall not exceed 125 spores per 10 grams of sugar.

Aerobic Flat Sour Spores, shall not exceed 50 spores per 10 grams of sugar.

Anaerobic Sulfide Spoilage Spores, shall not exceed 5 spores per 10 grams of sugar.

Anaerobic Thermophilic Hard Swell Spores, shall not be present in more than four of the six tubes of media inoculated with the test sample.

Standards have not been established for mesophilic organisms although for the dairy and beverage industry it has been suggested that the total plate count should not exceed 100 organisms per gram of sugar. Almost complete freedom from molds and yeast is required. The results of the examination of the samples for thermophilic and mesophilic organisms are given in Table II.

TABLE II

Bacteriological Examination of 1942 Sugars

	THERMOPHILIC BACTERIA				MESOPHILIC ORGANISMS			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeast	Molds
Sample Number	Total Count per 10 g.	Flat Sour per 10 g.	Sulfide Spores per 10 g.	Hard Swell % Tubes With Growth	Total per 1.0 g.	Acid per 1.0 g.	Total per 1.0 g.	Number Colonies per 1.0 g.
4201	55	35	0	0	23	5	0	0
4202	55	35	0	0	8	7	0	0
4203	0	0	0	0	3	0	0	5
4204	10	5	0	0	1	1	0	0
4205	5	0	0	0	3	0	0	3
4206	30	10	0	0	7	0	0	0
4207	0	0	0	0	2	2	0	1
4208	70	20	0	0	147	140	0	2
4209	50	20	0	0	18	15	0	0
4210	25	10	0	0	4	0	0	0
4211	70	40	0	0	2	2	0	24
4212	40	15	0	0	14	10	0	2
4214	35	10	0	0	4	1	0	2
4215	40	0	0	0	1	1	0	7
4216	10	5	0	0	1	1	0	2
4217	20	15	0	0	33	23	0	6
4218	60	5	0	0	3	0	1	0
4219	20	10	0	0	2	0	0	0
4220	10	10	0	0	65	65	0	3
4221	10	10	0	0	1	1	0	0
4222	5	0	0	0	18	3	0	0
4223	10	0	0	0	3	3	0	0
4224	15	15	0	0	8	0	0	1
4225	5	5	3	0	3	3	0	1
4226	0	0	0	0	22	19	0	0
4227	5	0	0	0	165	*	0	0
4228	110	100	0	0	304	304	0	0

* Impossible to estimate number of acid type colonies.

TABLE II (continued)

Bacteriological Examination of 1942 Sugars

	THERMOPHILIC BACTERIA				MESOPHILIC ORGANISMS			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeast	Molds
Sample Number	Total Count per 10 g.	Flat Sour per 10 g.	Sulfide Spores per 10 g.	Hard Swell % Tubes With Growth	Total per 1.0 g.	Acid per 1.0 g.	Total per 1.0 g.	Number Colonies per 1.0 g.
4229	50	50	0	17	8	8	0	1
4230	20	10	0	0	3	0	0	0
4231	15	5	0	0	12	6	0	1
4232	0	0	0	0	3	0	0	1
4234	10	5	0	0	147	108	0	0
4235	5	0	0	0	5	2	0	0
4236	0	0	0	0	48	30	0	1
4237	10	0	0	0	1	1	0	1
4238	45	30	0	0	10	3	0	0
4239	0	0	0	0	4	2	0	0
4240	10	10	3	0	6	2	0	0
4241	10	5	0	0	17	5	0	2
4242	0	0	0	17	7	2	0	0
4243	10	0	0	17	4	0	1	0
4244A	0	0	0	0	8	8	0	3
4244B	10	10	0	0	13	10	0	1
4245	5	5	0	17	1	1	0	2
4246	5	5	0	0	2	2	0	1
4247	5	5	0	0	2	2	0	0
4249	0	0	0	0	45	40	0	0
4250	35	20	0	0	4	4	0	2
4251	265	250	0	0	10	10	0	0
4252	225	220	0	33	7	4	0	1
4253	0	0	0	0	33	30	0	3
4254	5	5	0	0	8	6	0	1
4255	5	5	0	0	37	37	0	250
4256A	5	5	0	0	15	0	0	0
4256B	10	10	0	0	11	0	0	0
4257	10	10	0	0	3	3	0	1

TABLE II (continued)

Bacteriological Examination of 1942 Sugars

	THERMOPHILIC BACTERIA				MESOPHILIC ORGANISMS			
	Aerobes		Anaerobes		Aerobic Bacteria		Yeast	Molds
Sample Number	Total Count per 10 g.	Flat Sour per 10 g.	Sulfide Spores per 10 g.	Hard Swell % Tubes With Growth	Total per 1.0 g.	Acid per 1.0 g.	Total per 1.0 g.	Number Colonies per 1.0 g.
4258	210	210	0	0	1	1	0	0
4259	10	5	0	0	7	5	0	3
4260	10	10	0	0	3	2	0	1
4261	0	0	3	0	10	5	0	0
4262	10	10	0	0	3	3	0	0
4263	20	15	0	0	16	10	0	13
4264	20	15	0	0	10	3	0	0
4265	15	15	0	0	16	8	0	1
4266A	15	15	0	0	1	1	0	0
4266B	15	15	0	0	2	1	0	0
4267	5	5	0	0	2	0	0	2
4269	15	15	0	0	6	4	0	0
4270	25	25	0	0	6	6	0	2
4271	5	5	0	0	2	2	0	0
4272	0	0	3	0	34	30	0	0
4273	0	0	0	0	82	60	0	1
4274	5	5	0	0	**	**	**	**
4275	30	20	0	0	46	30	0	2
4276	0	0	0	0	6	5	0	0
4277	15	15	0	0	11	11	0	0
4278	40	40	0	0	7	5	0	2
4279	10	10	0	0	6	2	0	2
4280	65	45	0	0	3	2	0	0
4282	15	15	0	0	91	57	0	7
4283	0	0	0	0	6	2	0	0
4284	20	15	0	0	12	0	0	0
4290	0	0	0	0	1	0	0	8
4291	25	25	0	17	21	21	0	0
4294	5	5	0	0	150	150	0	3
4295	35	35	0	33	6	6	0	1

** Plates overgrown with molds; impossible to estimate number of colonies

There is an improvement in the bacteriological quality of the sugar this year. Only four samples (4.6 percent) failed to meet the specifications for canning-grade sugar. This is in comparison with ten samples, or 11.5 percent, for the 1941 campaign. All samples failing to meet the specifications had excessive total and/or flat sour type thermophilic spores. Three of the samples having excessive thermophilic bacteria counts were from factories which also had excessive numbers of bacteria during the two previous campaigns. A comparison of the total and flat sour type counts for these samples for the past two campaigns shows that there are fewer bacteria in the samples just examined. It is hoped that this improvement will continue during the forthcoming campaign. The total number of samples tested and passing canning-grade specifications since 1935 are given as follows:

Year	No. Samples Tested	No. Samples Passed	Percent Samples Passed
1942	87	83	95.4
1941	87	77	88.5
1940	87	81	93.1
1939	75	65	86.7
1938	77	74	96.1
1937	70	65	92.9
1936	70	59	83.6
1935	65	47	72.4

Five samples (5.7 percent) contained more than 100 mesophilic bacteria per gram of sugar, when plated on dextrose tryptone agar and incubated at 32° C. This is an improvement over last year when eleven samples, or 12.6 percent, contained more than 100 bacteria per gram. Two samples contained yeast but not more than one per gram when plated on wort agar. Nine samples contained five or more mold colonies per gram of sugar when plated on wort agar and incubated at 32° C. Samples 4255 and 4274 were excessively contaminated with 250 colonies or

more per gram. It is felt that five or more mold colonies per gram of sugar is an indication of undue exposure of the sugar to sources of infection in the sugar end of the factory, or to careless handling of the composite. Investigation should be made immediately for possible sources of contamination.